Individual Consumption, Time Use and their Distribution for the Dutch Population

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DOI:
10.33612/diss.102593753

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Publisher: University of Groningen
Groningen, The Netherlands

Printed by: Ipskamp Printing

ISBN: 978-94-034-2105-6 (printed)
978-94-034-2104-9 (electronic)

Individual Consumption, Time Use and their Distribution for the Dutch Population

PhD thesis

to obtain the degree of PhD at the
University of Groningen
on the authority of the
Rector Magnificus Prof. C. Wijmenga
and in accordance with
the decision by the College of Deans.

This thesis will be defended in public on

Monday 2 December 2019 at 14.30 hours

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Acknowledgements

About ten years ago when I was just beginning my studies, I would not have imagined finishing a PhD today. There were two reasons. The first is simply that the possibility was not on my radar. The second was that I was not instantly in love with my chosen program (Economics and Business Economics). Fortunately, my mother gave me a bit of good parental advice: Nobody likes every aspect of what they do, try looking for the part of what you do that you like most and focus on that. I am happy I took this advice. Economics got more interesting as I stuck with it, in no small part thanks to the great lecturers here in Groningen. In particular, I enjoyed courses with research assignments. When I learned about the Research Master I was immediately interested. My interest in the micro-economics of household behavior came later, and was inspired in part by Rob Alessie and Viola Angelini's courses Public Economics and Microeconomics of Household Behavior. These courses discuss major economic decisions that households make and the (institutional) context in which such decisions are made. What fascinated me in particular was how varied the outcomes of such decisions are. I was thus happy to start a research project under the supervision of Rob and later Jochem de Bresser, exploring how intra-household interactions between members and household composition affect households' decisions about how to spend their money and time.

The first people to thank are of course my supervisors Rob and Jochem. I could not have asked for people who are easier and more pleasant to work with. They were content to give me the room to figure things out for myself, but always happy and able to help when I got stuck. Rob is kind, patient and has an encyclopedic knowledge of both the theoretical and empirical side of things. I have gotten to know Jochem as very enthusiastic and quick-thinking, usually able to understand a problem within moments. They make an excellent team.

I would like to thank the assessment committee members Arthur van Soest, Adriaan Soetevent and Frederic Vermeulen for taking the time to read the manuscript and provide useful comments.

Perhaps most importantly I would like to thank my family, who have helped and supported me through the hardest parts of this journey. My mother Sjoukje for always lending a listening ear and offering support and advice. My sister Iris for helping me find ways to take my mind of work. My aunt Annie Tiekstra for taking such an interest in my life (and work), generally during conversations while bicycling or over dinner.

It is very easy to lose track of the bigger picture without regularly being challenged by someone with a fresh take on what you are doing. I would therefore like to finish by sincerely thanking friends and colleagues who in some big or small way commented on or showed an interest in my work. These conversations made a big difference.

Bart van Leeuwen
Groningen, October 21, 2019

Contents

Chapter 1

Introduction

1.1 Motivation

In recent years there has been renewed academic interest in economic inequality. A number of recent studies have found that income and wealth inequality have risen in Europe and the US.[1] These findings seem to have sparked a renewed interest in economic inequality amongst the public and policy makers. Economic inequality exists when individuals do not have the same resources and opportunities to improve their economic welfare. Economic welfare is fundamentally a subjective measure. While it can be measured (e.g. in a survey), economic welfare is not necessarily comparable across individuals. Economic welfare is generally understood to mean welfare derived from goods, services and various time uses. Studies of income and wealth are informative because they measure inequality in resources available for consumption. Income and wealth can thus be seen as objective measures of economic welfare. This dissertation takes a more direct approach by focusing on inequality in expenditure on consumption goods and services (consumption hereafter). Consumption is arguably a more meaningful measure of lifetime welfare. The lifecycle model suggest that people smooth their consumption in response to (temporary) deviations from expected average lifetime income (permanent income), see Blundell, Pistaferri, and Preston

[1]Wealth inequality has been the topic of Kopczuk and Saez (2004), Bricker et al. (2016), Saez and Zucman (2016) for the US, Piketty (2011) for France and Roine and Waldenström (2009) for Sweden. Studies such as Piketty and Saez (2014) and Roine and Waldenström (2015) consider multiple countries. Some of these studies also consider income inequality. Studies of income or consumption inequality are discussed in Chapter 4.

(2008). Viewed over the lifecycle per period welfare is thus more strongly correlated with consumption than with income. This dissertation therefore uses consumption inequality as a measure of economic inequality. Chapter 4 analyzes trends in individual consumption inequality for the Netherlands. Chapter 2 discusses the related topic of poverty. All three main chapters of the dissertation involve comparisons of consumption levels of some sort.

A problem of any inequality analysis (whether based on consumption, income or wealth) is how one can compare households of various types. A direct comparison of household expenditure is only meaningful when we can be confident that each member can fully enjoy the consumption value of every good that is bought. Therefore, direct comparisons are only possible amongst single person households. To make meaningful comparisons between other household types, analysts traditionally scale household expenditure levels for household size using so-called equivalence scales. Equivalence scales are defined as E_h/E, where E_h is the level of expenditure that a household of type h would need to be as well off as a single person who spends E. Equivalence scales can be used to divide expenditure of households of type h. The result is an expenditure level equivalent to that of a single person with the same utility as the household.

Browning, Chiappori, and Lewbel (2013) raise two conceptual problems with equivalence scaling. First, the method relies on interpersonal utility comparisons (between single individuals and other households). Such a comparison implies cardinality of utility; i.e. utility levels mean the same thing to different people. This is a very strong assumption, which lacks empirical support. Second, equivalence scales are based on unitary models of household decision making. These models treat the household as a single entity that makes decisions and experiences welfare. However, it is individuals rather than household who experience welfare. Moreover, these models miss key features of household decision making processes. Studies such as Blumberg (1988), Bourguignon et al. (1993), and Browning, Bourguignon, et al. (1994) show that the way a household allocates its budget depends on which person in a household receives income. This finding rejects the so-called "income pooling hypothesis" implied by the unitary model. Consequently, household allocations should be modeled as if multiple members are making decisions collectively. Collective models treat the household as a collection of individuals each with their own preferences, welfare and (possibly) a say in household decisions. Vermeulen (2002) surveys the collective household decision making literature. Important recent contributions include Blundell, Chiappori, and Meghir (2005), Lewbel and Pendakur (2008), Lise and Seitz (2011), Cherchye, de Rock, and Vermeulen (2012b), Browning, Chiappori, and Lewbel (2013) and Dunbar, Lewbel, and Pendakur (2013). These studies typically find a positive relation between an individual's decision making power and their personal income (usually non-labor income and usually personal income relative to the personal income of other members). These studies can therefore explain the rejection of the income pooling hypothesis.

Browning, Chiappori, and Lewbel (2013) propose indifference scales as an alternative to equivalence scales. Indifference scales are the share of household expenditure that a member of a household would need when living alone in order to keep their utility at the level achieved in the household. Indifference scales are based on collective models and avoid interpersonal utility comparisons. Indifference scales depend on individual consumption and reflect intra-household inequality. The unitary model underlying equivalence scales assumes away intra-household inequality. In this dissertation I will rely on indifference scales to compare consumption levels across household types.

The overall goal of this dissertation is to use recent advances in collective modeling and detailed micro-panel surveys to address policy relevant questions in the field of (micro)economics of household behavior. Section 1.2 introduces these research questions and the most important findings of the dissertation. The chapters share more than a modeling approach. I discuss a number of common themes in Section 1.3. Results related to these common themes are discussed in Chapter 5. This concluding chapter also contains policy recommendations based on the findings of the dissertation.

1.2 Main research topics

The main research question addressed in Chapter 2 is whether individual preferences of single persons and couple members over various types of expenditure are equal, controlling for gender. Chapter 2 considers the household's problem of allocating a budget to market goods. Unitary models cannot be used to identify separately the (allocation) preferences of both members of a couple, the extent to which each member controls household resources and the extent to which the couple enjoys economies of scale in consumption (relative to single persons).[2] Therefore, a "clean" test of the aforementioned preference equality assumption is not possible in unitary models. Dunbar, Lewbel, and Pendakur (2013) tests for equality of parameters across household types in a collective model. However, the parameters they test reflect differences in both preferences and economies of scale between household types. Chapter 2 introduces a new identifying assumption for collective models which permits a test of preference equality.

A number of early empirical applications of collective modeling such as Bargain and Donni (2012), Cherchye, de Rock, and Vermeulen (2012a) and Browning, Chiappori, and Lewbel (2013) were identified by making the preference equality assumption. The identifying assumption in Browning, Chiappori, and Lewbel (2013) is that single persons and otherwise similar members of couples have the same preferences towards allocating a budget between market goods. The identifying assumption introduced in Chapter 2 is a relaxed version of the full preference equality assumption of Browning, Chiappori, and Lewbel (2013). I estimate a modified version of the Browning, Chiappori, and Lewbel (2013) model under both the full preference equality assumption and the relaxed version. The chapter uses data from the Longitudinal Internet Studies for the Social sciences (LISS hereafter) panel. I can relax the preference equality assumption because LISS consumption data for a number of goods can be assigned to individual household members. I find that the full preference equality assumption should be rejected in favor of the relaxed alternative. The latter explains consumption allocation differences within and between household types significantly better.

Chapter 2 also checks whether the use of collective modeling leads to revised estimates of such policy relevant measures as indifference scales and poverty lines. I produce revised couples poverty lines. At this couples poverty line both couple members are as well off as they would be living alone at the single-person poverty line.

In Chapter 3 a collective model is used to study the relation between the use of formal child care and its cost. The analysis focuses on the effects of a reform that reduced the generosity of a subsidy for formal child care in the Netherlands. The reform consisted of a series of subsidy cuts implemented

[2] In this context economies of scale arise because a couple can share in the consumption of some goods, e.g. the house, furniture or vehicles. Economies of scales take the form of an effective price for consumption below the market price single persons pay for these goods.

in the years 2011, 2012 and 2013. The main goal of Chapter 3 is to evaluate the effect that these subsidy cuts have had on child care arrangements and labor supply.

There is a large literature that studies the relation between daycare costs and labor supply. Early contributions including Blau and Robins (1988), Connelly (1992), and Ribar (1992) estimated reduced form relations between labor supply and daycare cost. More recent studies such as Bettendorf, Jongen, and Muller (2015) and Hardoy and Schøne (2015) improve on this approach by exploiting policy-induced variation in daycare costs. Studies such as Kornstad and Thoresen (2007) and Apps, Kabátek, et al. (2016) use structural unitary models to identify the relation between daycare cost and labor supply. These studies tend to find a negative relation between child care cost and maternal labor supply.

The approach of Chapter 3 differs from the aforementioned studies by adopting a structural collective modeling approach. I predict the effects of the daycare subsidy cut on a broad set of outcomes using a modified version of the structural collective household production model of Cherchye, de Rock, and Vermeulen (2012b). The model is estimated using time and expenditure allocation data from the 2009, 2010 and 2012 waves of the LISS panel. The subsidy rate depends on income. I can determine the subsidy for each household using income data from LISS. Furthermore, I use consumption, time use and background data from LISS and price data from Statistics Netherlands. This data allows me to estimate a complete demand system for goods and time uses including labor supply. The estimated model is then used to predict outcomes for the post-reform waves (2012 and 2015) using actual post-reform prices and counterfactual pre-reform prices of daycare. I interpret the difference between these predictions as the effect of the subsidy cut.

The structural modeling approach allows us to separate the effect of the subsidy cut from other macroeconomic events that may affect budget allocations and time use. This is especially relevant since the study covers the period of the Great Recession. Furthermore, the structural modeling approach allows me to perform ex-ante policy simulations. In contrast to comparable quasi-experimental studies I do not need to make a common trend assumption. There are a number of advantages to using the particular collective model of Cherchye, de Rock, and Vermeulen (2012b). First, it allows us to predict the policy effect on labor supply by both the father and mother. Second, it allows us to predict how the mix of child care by father, mother and child care professionals changes. Third, we gain insights in the policy's effect on private consumption, public consumption, domestic work and leisure time consumption of both parents as well as the welfare of both parents and children. This is a wider set of outcomes than studied by Apps, Kabátek, et al. 2016 (and Kornstad and Thoresen 2007). They treat paternal time use as exogenous and do not distinguish between parental child care and domestic work or private and public consumption.

For the 2012 sample of households the 2011-2012 subsidy cuts have led to a 53% increase in the net-of-subsidy price of daycare (relative to the price they would have paid under 2010 rules). I predict that this increase in child care cost would have had a strong negative effect on daycare use. Gross of subsidy spending on daycare is reduced by 42% relative to the counterfactual. The predicted effect on labor supply, other time uses and non-daycare expenditure by either parent are not economically significant. The predicted effects of the 2011-2013 subsidy cuts on the 2015 sample are somewhat stronger. However, only the effect on daycare use is economically significant. Welfare of children is predicted to be negatively affected. Daycare use is reduced but parental child care time is not increased to compensate.

A second goal of Chapter 3 is to better explain time and expenditure allocation differences between one and two-earner households, and between households that do and do not use daycare. I do so in a way that is consistent with both rationing theory and collective modeling. Two forms of rationing are possible in the labor supply-daycare use decision. In case of labor supply, non-negativity of labor supply implies that all (other) time uses together are rationed at the time endowment. Demand for all (other) time uses should be evaluated at the market wage when labor supply is positive and otherwise at the reservation wage.[3] In case of daycare use, non-negativity implies all (other) goods together are rationed at the available budget. Demand for all goods should be evaluated at the price of daycare when daycare demand is positive and otherwise at a shadow price of daycare.[4] Incorporating rationing in the model of Chapter 3 is especially important since only couples with two employed members are eligible for the Dutch daycare subsidy. The reserva-

[3]The reservation wage is defined as the wage that makes an individual indifferent between working and not-working.

[4]The shadow price of a good is defined as the price that makes an individual indifferent between consuming the good and not consuming the good.

tion wage and shadow price of daycare cannot be observed. Instead I rely on the structural model to derive internal estimates of the reservation wage and shadow price at each step of the model's iterative estimation procedure. This method is roughly equivalent to a method employed by Kooreman and Kapteyn (1986) to study household labor supply in a unitary framework. Incorporating rationing theory in a collective model with a labor supply decision is an important contribution of Chapter 3. It allows such models to be extended to single earner households.

Chapter 4 studies inequality in individual (full) consumption expenditure for the employed working age population of the Netherlands during and after the Great Recession (2009-2017). The main goal of the chapter is to get an as detailed as possible picture of consumption inequality at the individual level. The analysis focuses on the working population of the Netherlands. I consider inequality both within and between the various household types that make up the working population. To do so consumption of single person households and larger households should be made comparable. Consumption is not directly comparable due to the existence of economies of scale in the consumption of some goods. Economies of scale in consumption exist when individuals can consume goods for a lower effective price when their households is larger.[5]

Chapter 4 uses a consumption measure called Singles Equivalent Full Individual Consumption (SEFIC), which equals household expenditure multiplied by an indifference scale. These particular indifference scales are calculated based on a version of the collective model of household production of Chapter 3. The model is extended to be applicable to singles and couples with and without children. SEFIC values an individual's private consumption, leisure, and the benefit they receive from consumption of public goods. Chapter 4 again uses the LISS TUC data to estimate the collective model. The variance of the logarithm of SEFIC is used as the main measure of inequality in Chapter 4.

I find that inequality in SEFIC is significantly higher than inequality in equivalent household full expenditure. The latter equals household expenditure on market goods plus the value of non-working time divided by an

[5]For example, a couple or a single person would pay the same rent for the same house. Because both members of the couple get to enjoy the house they effectively pay a lower price for their consumption of the house.

OECD modified equivalence scale.[6] Inequality in SEFIC is lower than inequality in equivalized after-tax household income. SEFIC inequality significantly increases from 2009 to 2010, decreases significantly from 2010 to 2012 and does not change significantly from 2012 to 2017. Over the 2009-2017 period SEFIC inequality fell significantly. When analyzing SEFIC inequality by gender, I find a significant reduction from 2009 to 2017 for men but no significant change for women.

Chapter 4 is closely related to Lise and Seitz (2011), who study the variance of the logarithm of individual consumption for the UK. Individual consumption equals the level of expenditure a household member consumes privately plus the level that is consumed publicly. Like Lise and Seitz (2011) I split the inequality in (singles equivalent full) individual consumption into within-household inequality and between-household inequality. In Chapter 4, the latter component can be further split into inequality between households of the same types and inequality between household types. Both are important components, accounting for respectively 53% and 31% of the overall variance. The time pattern of overall SEFIC inequality is primarily driven by the between-household component. I also construct individual-level inequality series for other outcome variables. Many of these are directly observable in the TUC data. These include expenditure on private goods, expenditure on public goods, leisure hours and domestic work hours. I construct individual consumption inequality according to the Lise and Seitz (2011) definition and repeat their analysis for the Netherlands using only observable data. The main difference with the SEFIC approach is that the latter estimates and incorporates heterogenous economies of scale into the consumption measure. Heterogeneity in economies of scale turns out to be an important source of consumption inequality.

1.3 Common themes

The chapters cover a number of common themes. Here I discuss the common themes and explain how each chapter approaches them. Results related to these common themes are discussed and compared in Chapter 5.

[6]The OECD modified scale equals 1 for a single persons, 1.5 for a couple and adds 0.3 for each child, see de Vos and Zaidi (1997).

1.3.1 Allocation differences between household types

All chapters are concerned with household budget allocation problems. That is, they study how the decision to buy specific goods and spend time on specific activities depends on a number of factors. Such factors include an individual's budget, the additional income they can earn from market work, the price of the specific goods under consideration and the price of all other goods that an individual may buy.

The chapters have in common that they approach this allocation problem as if it is static. In reality, households also face an inter-temporal allocation problem. Money can be saved or borrowed depending on whether a household desires to spend more or less than their income in a period. Households can decide to work more today if they want to work less in their old age. Throughout the thesis I assume that households engage in inter-temporal two-stage budgeting, and have decided on an optimal allocation of their resources across time. Their remaining problem of allocating their per-period resources to specific goods (and their time to activities) can then be seen in isolation. In other words, it can be studied separately from the factors that informed the inter-temporal budget allocation.

Chapter 2 studies how households allocate a monetary budget to 11 broad categories of goods. The chapter rejects the hypothesis that individual allocation preferences are independent of household type. Chapter 3 also discusses the allocation of monetary budgets. It focuses in particular on the effect of an increase in the price of daycare on the budget share allocated to daycare. Moreover, Chapter 3 extends the analysis to the allocation of time between work, leisure, child care and domestic work. Chapter 3 uses a rationing framework that helps explain allocation differences between single and dual earner couples and couples that do and do not use daycare. Similarly, Chapter 4 estimates a model explaining time and monetary allocations by single persons and couples with and without children. Consistent with the findings of Chapter 2 I allow partial household composition dependence of preferences. The model is used to determine SEFIC, a welfare metric that can be compared between household types.

1.3.2 Distribution of decision making power

All chapters are concerned with the distribution of decision making power between partners. Decision making power is, in this context, the degree to which a household member can affect the allocation pattern of the household (and thus control household resources). The models of collective household decision making used in these chapters formalize this notion by specifying the household's objective as maximization of a weighed sum of the welfare functions of the members of the household. The weights thus reflect decision making power. Following the literature, these 'bargaining weights' are modeled as a reduced form of relevant household and member characteristics.

The average bargaining weights are policy relevant statistics. In Chapter 3, a parent's bargaining weight determines the extent to which they rather than their spouse are affected by the daycare subsidy cut. For example, it affects to what extent each parent increases their child care time when the daycare subsidy is reduced. In Chapter 4, inequality in the control of resources is potentially an important driver of overall consumption inequality and in particular within-household inequality. Control over resources turns out to be quite equally distributed within Dutch households. In contrast to Lise and Seitz (2011), the within-household component plays a small role. This is the case intra-temporally because bargaining weights of partners are about equal on average. It is also the case inter-temporally because the within-household component is stable over time. In Chapter 5 I discuss and compare the bargaining weights estimated in Chapters 2-4.

1.3.3 Economies of scale in consumption

A common theme in Chapters 2 and 4 is that they are concerned with the economies of scale that exist in the consumption of market (and non-market) goods. In Chapter 2 there are economies of scale in the consumption of non-assignable goods (e.g. housing, utilities and transport). Singles pay the market price for consumption of these goods. Members of couples can share non-assignable goods with their partner to some extent. As a result they effectively pay a fraction of the market price to consume these goods. In the model of Chapter 4, economies of scale arise in the production and consumption of domestically produced goods. Economies of scale exist in production because the domestically produced goods are CES functions of time inputs of the household members with imperfect substitution between the two. A couple has twice the amount of time available as a single person, and benefits from (imperfect) complementarity between the inputs of its members. Similar to Chapter 2, economies of scale arise because the domestically produced goods can be shared (perfectly) between household members.

1.3.4 Equivalence versus indifference scales

Chapters 2 and 4 calculate indifference scales and compare these to equivalence scales. Equivalence scales are traditionally used to make individual-level comparisons of household-level income or expenditure data between different household types. In Chapters 2 and 4 I check whether equivalence scales are numerically close to the, theoretically more appropriate, alternative of indifference scales. In Chapter 5 I discuss and compare the indifference scales estimated in Chapters 2 and 4.

Chapter 2

Do Preferences over Consumption Depend on Household Composition? A Collective Approach to Household Consumption. [1]

2.1 Introduction

Households consisting of two (or more) persons make expenditure decisions in a fundamentally different way than single person households. When people start living together they are faced with the concept of sharing in two distinct ways. First, the members of the newly formed household will no longer have complete discretion over their household's expenditure. Instead household members share control over the budget. Typically each member will have some influence on the allocation of household resources. Second, the household members share in the use of some purchased goods. The multiple person household thereby realizes a more efficient use of goods compared

[1] This study represents joint work with Rob Alessie and Jochem de Bresser. We would like to thank two anonymous referees for useful feedback and suggestions. We thank Raun van Ooijen and Marcos Rangel for serving as discussants of this paper at respectively the 2016 SOM and 2017 SEHO conference. Furthermore, we thank the participants of the 2016 SOM conference, 2016 ESPE conference and 2017 SEHO conference for helpful comments and suggestions.

to a single person household. Since Chiappori (1988, 1992) and Apps and Rees (1988) such ideas have been formalized in collective household decision making models. An issue that has received little attention in the collective modeling literature is whether living with others makes certain goods intrinsically more attractive. This paper addresses the role that preference differences between single persons and members of childless couples play as a complementary explanation for differences in the composition of their consumption bundle. Using a dataset with individual consumption data for couple members (and single persons) we test whether preferences of single persons and couple members are equal, controlling for gender.

We use a model based on Browning, Chiappori, and Lewbel (2013) which allows preferences over the consumption of a subset of individually assignable goods and services to depend on the composition of the household. Decisions are made in cooperation as in the model of Chiappori (1988). The consumption allocation is Pareto efficient. Efficiency gains from shared consumption are modeled as economies of scale in a household production process as in Browning, Chiappori, and Lewbel (2013).

The idea that preferences may differ between single persons and couple members has not gone entirely unexplored. Browning, Chiappori, and Lewbel (2013) discuss data requirements and assumptions needed to identify separate preference sets for singles and couple members. Identifying separate preferences for singles and couples can be challenging. Consumption expenditure data tends to be collected at the household level, through household surveys. The challenge is that differences in expenditure patterns of single and multiple person households can be attributed to preference differences, economies of scale in consumption or the relative influence of the members of a multiple person household.

In practice identification of collective models is achieved by making one or more strong assumptions. For example Browning, Bourguignon, Chiappori, and Lechene (1994) and Lise and Seitz (2011) assume that couples share income equally when members earn equal wages. Lewbel and Pendakur (2008) develop a version of the model of Browning, Chiappori, and Lewbel (2013) which is identifiable from cross-sectional data. Bargain and Donni (2012) use the model of Lewbel and Pendakur (2008) to derive estimates of sharing and economies of scale for households with children. They are also able to test for household composition dependence of preferences. Their identifying assumption is that a household member's share of total expenditure is independent of the level of total expenditure. However, this assumption is rejected in de Ree, Alessie, and Pradhan (2013). Cherchye, de Rock, and Vermeulen (2012a) assume that preferences of members of an elderly couple are the same as elderly widow(ers). In Browning, Chiappori, and Lewbel (2013) the model is identified by assuming that all preference parameters are the same for singles and couple members. For a given budget and prices, singles and couple members allocate the same budget shares to goods.

Our innovation is to weaken this assumption by allowing preference parameters exclusive to assignable goods demand function to differ between singles and members of couples. For a given budget and prices, singles and couple members allocate the budget differently amongst assignable goods but similarly amongst non-assignable goods. We refer to original assumption as full household composition independence of preferences (HCIP hereafter) and the weakened assumption as partial HCIP. We use the model identified under partial HCIP to test the nested full HCIP assumption. Full HCIP is rejected. We find that imposing full HCIP substantially affects estimates of bargaining power, economies of scale, and such policy relevant measures as indifference scales and poverty rates.

This paper is closely related to Dunbar, Lewbel, and Pendakur (2013). The empirical part of Dunbar, Lewbel, and Pendakur (2013) is focused on households with children. However, their proposed Similarity Across Types (SAT) assumption can be applied to a childless singles-childless couples context as well. Within a system of linear Engel scales the SAT assumption is a restriction on the slopes of (a subset of) Engel scales. Intercept parameters are allowed to be household composition dependent. SAT thus places a comparatively weak assumption on preferences. However, these household composition dependent intercept parameters reflect both preference differences and scale economies. SAT therefore does not permit a pure test of whether preferences depend on household composition.

Partial HCIP shares the advantages of (full) HCIP. First, HCIP allows a collective model to be identified in situations without price variation, labor supply data or information on couple members' outside options (e.g. marriage market data). In particular, preferences, economies of scale and bargaining parameters can be separately identified.[2] Second, HCIP does not impose strong restrictions on the shape of Engel curves.[3] Third, HCIP does

[2]This is a problem when using the SAT assumption, as Section 2.3.3 discusses.

[3]As opposed to e.g. the independence of base assumption introduced in **lewbel1989**

not impose that utility is separable in the consumption levels (of groups) of goods. When expenditure data for more than one per household member is observed, full HCIP can be weakened to partial HCIP. The latter uses variation in the allocation amongst the assignable goods to identify household composition dependent preference parameters. Variation in the non-assignable goods budget shares of singles identifies all other preference parameters. Variation in the non-assignable goods budget shares of couples identifies the sharing rule and economies of scale. Crucially, the ability to separate preference differences from effects of economies of scale allows us to perform a clean test of HCIP. In contrast under the SAT assumption it is only possible to test household composition independence of parameters which confound preference differences with economies of scale.

We use the Longitudinal Internet Studies for the Social Sciences (LISS) Time Use and Consumption dataset to estimate our model. The LISS data records expenditure of individual members of households on a number of goods and services. In addition, it records the expenditure of their household on several non-assignable goods. Hence the LISS data fulfills the data requirements to use the partial HCIP assumption. In our sample 36% of total expenditure on goods other than housing or utilities is recorded at the individual level.

We calculate indifference scales for couple members in the spirit of Browning, Chiappori, and Lewbel (2013). Indifference scales tell us how much income a person would need living alone to be as well off as he/she would be when living as part of a couple. In this paper we produce indifference scales that are consistent when preferences depend on household composition. Indifference scales have a variety of uses. For example, they can be used to measure consumption inequality or poverty at an individual level. Indifference scales are therefore relevant for policy evaluation.

We demonstrate this by calculating a refined poverty threshold for couples using indifference scales. The refined threshold is based on the idea that both couple members should be kept indifferent to being single at the singles poverty line. A conventional couples poverty threshold classifies as out of poverty some individuals who would be better off single at the singles poverty line. The refined threshold is defined to rule out this possibility. Indifference scales may also be of use in policy design. A policy maker may face the problem of constructing program eligibility (income) thresholds for a number of household types. For some programs an important consideration is that the thresholds are set in such a way that people in different household types become eligible at the same level of relative deprivation. Relevant examples include social housing, rent subsidy or health care benefit programs. Indifference scales can be used to determine the thresholds for all household types consistent with a specific level of deprivation for single persons. If this is the only consideration then the aforementioned thresholds can be used directly. If there are other considerations then the indifference scales based threshold can be used as guidance.

Testing whether HCIP holds is important for at least two reasons. First, household composition dependence of preferences may help explain some changes in allocation over an individual's lifetime. Consider for example a couple who enjoys visiting the theater together. In case the couple splits up, the newly single individuals may find that they no longer enjoy theater visits as much without a partner to join them. Consequently, they may spend less on this activity. Studies such as Hamermesh (2002) and Stancanelli and Van Soest (2016) reveal that there are complementarities to leisure time, the former for dual earner couples and the latter for pre- and post-retirement couples. It seems a small leap to suggest that there could also be externalities in the goods and services enjoyed during joint leisure time. One way of capturing these externalities is to assume that one's company affects one's taste for goods, services and activities that can be enjoyed together. The preceding discussion about identification of the collective model provides a(nother) straightforward reason why a test of HCIP is important. If preferences depend on household composition and we impose HCIP then we bias the (policy relevant) estimates of economies of scale, intra-household sharing and indifference scales (see Browning, Chiappori, and Lewbel (2013) section 6.3). Here, we estimate versions of these measures that are robust to HCIP. Unfortunately, the preceding argument works both ways. Assumptions about the form of economies of scale will bias estimates of preference differences. We also test household composition independence of parameters in a model identified under SAT and reject this hypothesis.

The paper is structured as follows. In section 2.2 we start off with a discussion of the LISS dataset; its properties, and its limitations. Section 2.3 describes the empirical implementation of a Browning, Chiappori, and Lewbel (2013) style model with household composition dependent preferences. Section 2.4 starts with a discussion of the test of HCIP and several other hypotheses related to preferences. Subsequently, we calculate and discuss expenditure shares, indifference scales and poverty thresholds for members of couples. Section 2.5 concludes with a discussion of the implications for future work.

2.2 Data

In this paper use is made of data from the LISS (Longitudinal Internet Studies for the Social sciences) panel administered by CentERdata (Tilburg University, The Netherlands). The LISS panel is a representative sample of Dutch individuals who participate in monthly Internet surveys. The panel is based on a true probability sample of households drawn from the population register. Households that could not otherwise participate are provided with a computer and Internet connection. A longitudinal survey is fielded in the panel every year, covering a large variety of domains including work, education, income, housing, time use, political views, values and personality. We use information about education, income and personal characteristics from these yearly studies in addition to data from the Time Use and Consumption (TUC) module used in Cherchye, de Rock, and Vermeulen (2012a,b). The TUC module contains detailed information about average monthly household and individual expenditures over the previous year. Data is available on a number of assignable goods and non-assignable goods.

The population of interest consists of childless singles and childless heterosexual couples where each member of the household is below the age of retirement of 65 (for the interval of time considered).[4] There are three waves of data available (2009, 2010, and 2012) with repeated observations on some households. We pool the waves of data and correct for the resulting correlation between errors of observations of the same household by using standard errors clustered at the household level.

Household level expenditure data is recorded in the TUC module for the following non-assignable goods; mortgage interest and amortization, rent, utilities, transport and means of transport, insurance, alimony and child support, servicing debts and loans, cleaning and maintenance of the house and garden, food consumed at home, and other non-assignable goods.[5] The

[4]Same sex couples are dropped because the subsample is too small to analyze.

[5]Transport and means of transport are recorded as one category. It includes expenditures on public transportation and usage and maintenance cost of owned means of transportation. It does not include vehicle insurance payments (covered by the insurance cat-

present study focuses on the allocation of total expenditure over goods and services. We therefore disregard the expenditures made to service debts and loans (except mortgage payments) and expenditures on alimony and child support. These categories do not represent goods or services. Expenditures on "other" non-assignable goods are disregarded because we cannot check whether this category actually contains non-assignable expenditures and it represents a small expenditure category.

The treatment of housing expenditures requires some extra attention. Note that rent and mortgage are not really comparable. Rent is a good measure of the cost of enjoying a rented house. Mortgage interest and amortization on the other hand is a poor indicator of the cost of enjoying an owned home. The sum of amortization and interest has no relation over time with the benefits of living in a house. Furthermore, after a mortgage has been repaid the owners of a house can still use the house. We would prefer to use imputed rent. Imputed rent measures the opportunity cost of living in an owned house. However, the mortgage measure is the best data we have available. As in Cherchye, de Rock, and Vermeulen (2012b), we stick with mortgage payments as the homeowner's cost of enjoying their home. Expenditures on mortgage payments and rent are combined with expenditure on cleaning and maintenance into a category we will simply refer to as housing. We use homeownership as a taste shifter in part to control for the effects of ignoring the difference between mortgage and rent. Furthermore, homeownership is allowed to affect the division of expenditure between partners and indirectly affect economies of scale.[6] We end up with 5 non-assignable good categories: housing, utilities, transport, insurance and food consumed at home.

Each respondent was asked to report expenditures for their personal consumption on a number of assignable goods. The TUC module uses the following assignable goods categories: expenditure on food and drinks outside the house, tobacco products, clothing, personal care products and services, medical care and health care cost not covered by insurance, expenditure on leisure time activities, schooling, donations and gifts, and other assignable goods. Medical care costs are disregarded because they do not represent

egory) or the purchase of means of transportation.

[6]Homeownership indirectly affects the extent to which an individual enjoys economies of scale by altering the allocation of expenditure to goods with economies of scale. Homeownership does not directly affect the strength of economies of scale in such goods.

the outcome of an individual's (own) choice. Schooling, donations and gifts, and other assignable goods are disregarded because the vast majority of the sample reports zero expenditures, and many of the other respondents report negligible amounts. We make several adjustments to the assignable goods data. First, we assign half of a couples' expenditure on joint vacations and day trips to the leisure activities expenditure of each member of the couple. We feel that this approach is justified by the fact that on a joint vacation couples usually undertake the same activities and spend equally on most major items (e.g. food, flight, accommodation). Second, we have chosen to combine expenditure on food and drinks outside of the home, tobacco, and leisure activities into a broad leisure expenditure category. Preliminary analysis revealed that the response of food and drinks (outside the home) and leisure activities categories to expenditure were positive, significant and quantitatively similar. The three assignable goods categories we analyze are leisure, clothing and personal care.

In Table 2.1 we report the loss of observations due to a number of sample selection criteria. First, an observation is discarded if expenditure on any assignable or non-assignable good category is entirely missing. We do not impute expenditure categories. In most cases households missing one (non-)assignable category missed all (non-)assignable categories. In couples each member had the option of indicating that they were not the person who knew about a particular non-assignable good category. Unfortunately in some couples both members chose this option and the corresponding expenditure level is missing.[7] We dropped observations missing non-assignable goods, and thereafter observation missing assignable goods. Second, we discard observations with zero reported expenditure on the sum of mortgage and rent if the household is renting a home or lives in a cost-free home. For renters zero expenditure seems implausible.[8] Since housing is a major expenditure for most households, we do not accept these instances of miss-measurement and delete them. Living in a cost free home is a sign that an individual is not

[7]Other cases were handled as follows: When only one member of a household reports strictly positive expenditures on a non-assignable good then those expenditures are considered. This includes cases where the other household member reports zero expenditure. When both members of a household report strictly positive expenditures on a non-assignable good then the average of the reported expenditures is considered. The same applies when both members report zero expenditure.

[8]One possibility is that the household is delinquent in payment. Unfortunately, we have no way of investigating this hypothesis.

completely financially independent. We discard these individuals because we are interested in households with complete control over their finances. It is far more common to live cost free for singles than for couples. Third, we consider only observations with non-zero total assignable and non-assignable goods expenditure. Fourth, we discard observations with missing explanatory variables. Finally, if the spouse of a member of a couple has incomplete data, then that member's data is not used. The final sample consists of 780 observations on single women, 727 observations on single men, and 847 observations on couples.

Table 2.1: Observations per sample selection criterion

	Singles		Couples		
Selection criterion	Women	Men	Women	Men	Total
Base sample[a]	1266	1143	1461	1461	5331
Non-assignable good missing	897	827	1085	1085	3894
Assignable good missing	860	794	976	985	3615
Infeasible housing	825	763	972	980	3540
Total expenditure=0	812	750	968	973	3503
Missing explanatory variables	780	727	911	916	3334
Partner was discarded	780	727	847	847	3201

[a]Single or part of a heterosexual couple where both partners participate.

Descriptive statistics for monthly expenditure on the non-assignable and assignable goods are reported in Table 2.2. Housing is the largest expenditure category for all household types, followed by food consumed at home. The order differs by household type thereafter.

Table 2.2 also reports descriptive statistics for background variables. We use background variables to model heterogeneity in individual preferences and to explain the intra-household distribution of expenditure by couples. The taste shifters we include are a homeownership dummy, a higher education dummy and age. Homeownership may affect the allocation. For example by making expenditure on cleaning and maintenance, furnishing, and insurance more attractive relative to other goods. We use a dummy which is equal to 1 if the household lives in an owned home. Education may affect preferences by promoting healthy choices. Alternatively it may affect preferences through an individual's peer/social network. The higher education dummy equals 1 if the respondent has received a degree in the higher education system (higher

Table 2.2: Descriptive statistics

Variable	Single women Mean	Single women Std. Dev.	Single men Mean	Single men Std. Dev.
Household expenditure (€/month)	1334.75	523.34	1357.41	516.93
Non-assignable goods[a]				
Housing	0.37	0.13	0.36	0.14
Utilities	0.14	0.06	0.12	0.07
Transport	0.06	0.05	0.07	0.07
Insurance	0.12	0.07	0.12	0.07
Food at home	0.15	0.07	0.16	0.08
Assignable goods[a]				
Leisure	0.08	0.07	0.11	0.09
Clothing	0.05	0.05	0.04	0.05
Personal care	0.03	0.02	0.02	0.02
Taste shifters				
Homeowner	0.43	0.49	0.50	0.50
Higher education[b]	0.44	0.50	0.31	0.47
Age	48.24	12.81	46.66	11.74
Observations	780		727	

Source: CentERdata. Based on own calculations. [a] Shares of household expenditure. [b] Higher education is a dummy equal to 1 if the respondent completed a higher vocational or university level degree.

Table 2.2: continued

	Women in couples		Men in couples	
Household expenditure (€/month)	2304.22	1227.56		
Non-assignable goods[a]				
Housing	0.29	0.14		
Utilities	0.11	0.05		
Transport	0.07	0.05		
Insurance	0.13	0.07		
Food at home	0.16	0.07		
Assignable goods[a]				
Leisure	0.07	0.05	0.08	0.06
Clothing	0.03	0.03	0.02	0.03
Personal care	0.02	0.02	0.01	0.01
Taste shifters				
Homeowner	0.78	0.42	0.78	0.42
Higher education[b]	0.24	0.43	0.36	0.48
Age	49.08	12.79	51.19	12.49
Distribution factors				
Wife-husband age difference	-2.11	3.85		
Wife's income share	0.30	0.21		
Married	0.79	0.41		
Observations	847		847	

Source: CentERdata. Based on own calculations. [a] Shares of household expenditure. [b] Higher education is a dummy equal to 1 if the respondent completed a higher vocational or university level degree.

vocational or university level). We use the (demeaned) age in years of an individual as our age variable.

Following Chiappori (1992) and among others Browning, Chiappori, and Lewbel (2013) we model the intra-household distribution of resources by means of a sharing rule. We use a number of variables that have been suggested in the literature to affect the sharing rule. We allow some of these variables to only affect the intra-household distribution, so-called distribution factors in the terminology of collective models. The distribution factors we use below are the wife-husband age difference, the wife's share of net household income and a married couple dummy. We use a homeownership dummy, separate higher education dummies for the wife and husband and total household expenditure as additional explanatory variables in the sharing rule. Preliminary analysis has revealed that a dummy indicating whether the wife is the household head and several interactions of aforementioned variables with the income share/age difference are insignificant explanatory variables for the intra-household distribution.

2.3 Empirical model

The contribution of this paper to the collective modeling literature is not of a theoretical but of an empirical nature. Browning, Chiappori, and Lewbel (2013) forms the theoretical basis for our empirical analysis. Appendix A summarizes the model of Browning, Chiappori, and Lewbel (2013). Readers that are thoroughly familiar with Browning, Chiappori, and Lewbel (2013) can skip Appendix A without loss of continuity.

2.3.1 Parametric specification

The TUC module is a short panel study. We therefore have limited price variation. We specify a parametric model with limited interaction between prices of goods. Our starting point is a simplified version of the Almost Ideal Demand System of Deaton and Muellbauer (1980). We restrict to zero the parameters of products between the logarithms of prices which normally appear in such a model.[9] We are not able to identify substitution effects given the limited price variation in the TUC module. Consequently, price

[9]Referring directly to Deaton and Muellbauer (1980), we impose $\gamma_{j,k} = 0$ for all goods indexed by j and k.

changes only have an income effect on demand. We obtain an individual indirect utility function given by equation (2.1)

$$V^k(x^k, \boldsymbol{p}, \boldsymbol{z}^k) = \frac{\ln x^k - \ln a^k(\boldsymbol{p}, \boldsymbol{z}^k)}{b^k(\boldsymbol{p})} \tag{2.1}$$

where $k = sf, sm, cf, cm$ and

$$\ln a^k(\boldsymbol{p}) = \alpha_0 + \sum_{i=1}^{G_A} \alpha_i^k(\boldsymbol{z}^k) \ln p_i + \sum_{i=G_A+1}^{G} \alpha_i^k(\boldsymbol{z}^k) \ln p_i, \tag{2.2}$$
$$b^k(\boldsymbol{p}) = \prod_{i=1}^{G_A} p_i^{\beta_i^k(\boldsymbol{z}^k)} \prod_{i=G_A+1}^{G} p_i^{\beta_i^k(\boldsymbol{z}^k)}.$$

where $\boldsymbol{p}$ is the vector of market prices for all goods and x^k is (individual) total expenditure. We have explicitly recognized everywhere that the utility function depends on an individual's background variables $\boldsymbol{z}^k$. Perhaps the most important background variable is the gender of the individual. The superscript $k = sf, sm, cf, cm$ is used above to distinguish between functions, variables and parameters for single women, single men, women in couples and men in couples. We have $G_A = 3$ assignable goods and $G_N = 5$ non-assignable goods. The number of goods for singles is denoted by $G = G_A + G_N$ and for couples by $G_H = 2 \cdot G_A + G_N$.

Individual demand functions can be found by applying Roy's Identity to the indirect utility function. We multiply the individual demand function by p_g/x^k for $l = A, N$ to find the budget shares

$$w_g^k = \frac{p_g q_g}{x^k} = a_g^k(\boldsymbol{z}^k) + \beta_g^k(\boldsymbol{z}^k)(\ln x^k - \ln a^k(\boldsymbol{p}, \boldsymbol{z}^k)) \quad \text{for } g = 1, \ldots, G \tag{2.3}$$

We recognize that there may be heterogeneity in preferences across individuals. To capture some of this heterogeneity we let the preference parameters (α's and β's) depend on the variables age, education and homeownership. Dependence on taste shifters is modeled as follows;

$$\alpha_g^k(\boldsymbol{z}^k) = \alpha_{g,c}^k + \boldsymbol{\alpha}_{g,z}^{k\prime} \boldsymbol{z}^k,$$
$$\beta_g^k(\boldsymbol{z}^k) = \beta_{g,c}^k + \boldsymbol{\beta}_{g,z}^{k\prime} \boldsymbol{z}^k,$$

where $\boldsymbol{z}^k$ contains observations on age, education and homeownership. We need the restrictions $\sum_{i=1}^{G} \alpha_{i,c}^k = 1$, $\sum_{i=1}^{G} \boldsymbol{\alpha}_{i,z}^k = \boldsymbol{0}$, $\sum_{i=1}^{G} \beta_i^k = 0$,$\sum_{i=1}^{G} \boldsymbol{\beta}_{i,z}^k =$

$\mathbf{0}$, in order for the systems to satisfy adding up. When estimating the model, we leave out one good as suggested in Barten (1968, 1969) and Pollak and Wales (1969). The parameters appearing in the budget shares of the excluded good are recovered using the adding up restrictions.

Individual demand

We normalize all prices in equation (2.3) to 1 and rewrite budget shares for singles as

$$w_g^k = (\alpha_{g,c}^k - \alpha_0 \beta_{g,c}^k) + (\boldsymbol{\alpha}_{g,z}^k - \alpha_0 \boldsymbol{\beta}_{g,z}^k)' \boldsymbol{z}^k + \beta_{g,c}^k \ln x + \boldsymbol{\beta}_{g,z}^{k\prime} \boldsymbol{z}^k \ln x \quad (2.4)$$

for $k = sf, sm$ and $g = 1, \ldots, G$, where we have suppressed the subscript identifying the observation to avoid clutter.

If we fix α_0, then the remaining parameters can be estimated from a model that is linear in reduced form parameters. The econometric model would be substantially simplified. As Deaton and Muellbauer (1980) noted, when prices are unity the parameter α_0 can be interpreted as the logarithm of subsistence spending in the Almost Ideal Demand System.[10] Banks, Blundell, and Lewbel (1997) argue that the minimum expenditure observed in the sample places an upper bound on (log) subsistence expenditure, and can therefore be used to fix α_0. We deviate somewhat from this practice and choose to set α_0 equal to the log of the 5th percentile of the distribution of total spending in single person households. Our justification of this more conservative approach is that some individuals in the sample may spend less than the subsistence level.[11] Since the 5th percentile is a somewhat arbitrary choice, we have checked robustness of the results to the choice of α_0. The results are qualitatively unchanged by choices of α_0 as high as the 25th percentile of total expenditure.

[10] From equation (2.1) we observe that if expenditure is no higher than α_0 (and prices are unity) then (sub-)utility is non-positive. Therefore α_0 can be interpreted as the logarithm of subsistence spending.

[11] In which case minimum expenditure in the sample would be below subsistence expenditure. We observe single persons spending as little as €40 in total. The minimum amount of expenditure seems insufficient to meet primary needs. As a measure of subsistence expenditure, the minimum of total expenditure in the sample may therefore be too low. Note that these very low expenditure are not necessarily a sign of poverty. The individual may simply have bought sufficient goods of a relatively durable nature in the past.

Couples demand

We can recover estimates of the sharing rule and economies of scale in consumption of non-assignable goods from the budget shares of couples. The general form of these budget shares is derived in Appendix B. Here we introduce a functional form for the share of expenditure going to the wife and the consumption technology. The consumption technology relates consumed quantities of non-assignable goods $q_g^{k,N}$ to purchased quantities $y_g^{k,N}$. We use a linear consumption technology

$$q_g^{k,N} = d_g^{-1} y_g^{k,N} \qquad \text{for } g = G_A + 1, \ldots, G$$

which results in effective prices given by $\pi_g = d_g p_g^N$. We follow Cherchye, de Rock, and Vermeulen (2012a) and impose these restrictions by using the functional form

$$\pi_g = d_g = \frac{1 + \frac{e^{\delta_g}}{1+e^{\delta_g}}}{2} \qquad \text{for } g = G_A + 1, \ldots, G$$

for economies of scale and estimating the parameters δ_g. In a preliminary analysis we were able to identify Barten scales albeit poorly.[12] We simplify the analysis by assuming that economies of scale parameters δ_g are all equal. In other words, we estimate an Engel scale for non-assignable goods. We perform a likelihood ratio test of the Engel scale assumption. The J statistic of the unrestricted model exceeds that of the restricted model by 0.46. With 4 restrictions we find a p-value of 0.98. Unsurprisingly given the poorly identified Barten scales, we do not reject the Engel scale assumption.

We assume that the sharing rule is given by the logistic function

$$\eta(\boldsymbol{s}) = \frac{e^{\boldsymbol{\kappa}'\boldsymbol{s}}}{1 + e^{\boldsymbol{\kappa}'\boldsymbol{s}}},$$

where $\eta(\boldsymbol{s}) = \frac{x^{cf}(\boldsymbol{s})}{x}$ and $\boldsymbol{s}$ contains the age difference between wife and husband, the wife's share of net household income, a married couple dummy, a

[12] The preliminary results imply that housing, utilities and transport (which includes public transport) lie at the public good extreme ($\pi_g^N = 0.5$). We obtain an effective price of 0.66 for insurance and 0.60 for food consumed at home. The results are imprecise in the sense that for each effective price, the 95% confidence interval encompasses almost the entire interval between 0.5 and 1. The results would no doubt have been more precise if we had access to intra-temporal price variation.

homeownership dummy, the logarithm of total household expenditure and a dummy for wife and husband's education.

The choice of sharing rule and the assumption that $\delta_g = \delta$ for all non-assignable goods allows us to rewrite the household expenditure shares as functions of the parameters $\boldsymbol{\kappa}$ and δ (derivations in Appendix B). We get

$$
\begin{aligned}
w_g^h &= \frac{p_g y_g^{cf}}{x} = \eta(\boldsymbol{\kappa}) \cdot w_g^{cf}(\delta, \boldsymbol{\kappa}, \boldsymbol{\zeta}^{cf}) && \text{for } g = 1, \ldots, G_A, && (2.5)\\
w_g^h &= \frac{p_g y_g^{cm}}{x} = (1 - \eta(\boldsymbol{\kappa})) \cdot w_g^{cm}(\delta, \boldsymbol{\kappa}, \boldsymbol{\zeta}^{cm}) && \text{for } g = G_A + 1, \ldots, 2 \cdot G_A, && (2.6)\\
w_g^h &= \frac{p_g y_g^{h}}{x} = \eta(\boldsymbol{\kappa}) \cdot w_g^{cf}(\delta, \boldsymbol{\kappa}, \boldsymbol{\zeta}^{cf}) \\
&\quad + (1 - \eta(\boldsymbol{\kappa})) \cdot w_g^{cm}(\delta, \boldsymbol{\kappa}, \boldsymbol{\zeta}^{cm}) && \text{for } g = 2 \cdot G_A + 1, \ldots, G_H, && (2.7)
\end{aligned}
$$

where $G_H = 2 \cdot G_A + G_N$, $\boldsymbol{\zeta}^k = [\boldsymbol{\zeta}_1^k, \ldots, \boldsymbol{\zeta}_{G_H}^k]$, $\boldsymbol{\zeta}_g^k = [\alpha_{g,c}^k, \boldsymbol{\alpha}_{g,z}^{k\prime}, \beta_{g,c}^k, \boldsymbol{\beta}_{g,z}^{k\prime}]$ and

$$
\begin{aligned}
w_g^{cf} &= \frac{\pi_g q_g}{\eta^{cf} x} = \alpha_g^{cf}(\boldsymbol{z}^{cf}) && (2.8)\\
&\quad + \beta_g^{cf}(\boldsymbol{z}^{cf}) \left[\ln(\eta(\boldsymbol{\kappa})x) - \alpha_0 - \sum_{i=G_A+1}^{G} \alpha_i^{cf}(\boldsymbol{z}^{cf}) \ln \pi(\delta) \right], \\
w_g^{cm} &= \frac{\pi_g q_g}{\eta^{cm} x} = \alpha_g^{cm}(\boldsymbol{z}^{cm}) && (2.9)\\
&\quad + \beta_g^{cm}(\boldsymbol{z}^{cm}) \left[\ln((1 - \eta(\boldsymbol{\kappa}))x) - \alpha_0 - \sum_{i=G_A+1}^{G} \alpha_i^{cm}(\boldsymbol{z}^{cm}) \ln \pi(\delta) \right]
\end{aligned}
$$

for $g = 1, \ldots, G_H$. Note that we use separate budget shares for the wife and the husband's expenditure on each assignable good. As a result we obtain a system of $G_H = 3 \cdot 2 + 5 = 11$ household level budget shares. Equations (2.8) and (2.9) contain couple members' budget shares defined relative to individual total expenditure $\eta^k x$. However, we do not observe this type of budget shares since individual total expenditure consists in part of unobservable non-assignable goods expenditure. We do observe the left-hand side of equations (2.5), (2.6) and (2.7). These are the budget shares defined relative to total household expenditure. We find equation (2.5) and (2.6) by multiplying equation (2.8) and (2.9) by η^k. We find equation (2.7) by multiplying equations (2.8) and (2.9) by η^k and adding up.

In order to identify the sharing rule parameters $\boldsymbol{\kappa}$ and effective price of non-assignable goods consumption π (or more accurately the underlying parameter δ) we assume that preference parameters of singles and couples members in the non-assignable goods budget shares are equal. In terms of equations (2.8) and (2.9) this amounts to

$$
\begin{aligned}
w_g^{cf} &= \alpha_g^{sf}(\boldsymbol{z}^{cf}) \\
&\qquad + \beta_g^{sf}(\boldsymbol{z}^{cf}) \left[\ln(\eta(\boldsymbol{\kappa})x) - \alpha_0 - \sum_{i=G_A+1}^{G} \alpha_i^{sf}(\boldsymbol{z}^{cf}) \ln \pi(\delta) \right], \\
w_g^{cm} &= \alpha_g^{sm}(\boldsymbol{z}^{cm}) \\
&\qquad + \beta_g^{sm}(\boldsymbol{z}^{cm}) \left[\ln((1-\eta(\boldsymbol{\kappa}))x) - \alpha_0 - \sum_{i=G_A+1}^{G} \alpha_i^{sm}(\boldsymbol{z}^{cm}) \ln \pi(\delta) \right].
\end{aligned}
$$

2.3.2 HCIP in general

Having introduced the necessary notation above we can now place the partial HCIP assumption in a more general context. In the general collective model household budget shares are given by

$$
\begin{aligned}
w_g^h &= \eta(x,\boldsymbol{p}) \cdot w_g^{cf}(\eta(x,\boldsymbol{p})x, \boldsymbol{\pi}) && \text{for } g = 1,\dots,G_A, \\
w_g^h &= (1-\eta(x,\boldsymbol{p}) \cdot w_g^{cm}((1-\eta(x,\boldsymbol{p}))x, \boldsymbol{\pi}) && \text{for } g = G_A+1,\dots,2\cdot G_A, \\
w_g^h &= \eta(x,\boldsymbol{p}) \cdot w_g^{cf}(\eta(x,\boldsymbol{p})x, \boldsymbol{\pi}) && \\
&\quad + (1-\eta(x,\boldsymbol{p})) \cdot w_g^{cm}((1-\eta(x,\boldsymbol{p}))x, \boldsymbol{\pi}) && \text{for } g = 2\cdot G_A+1,\dots,G_H,
\end{aligned}
$$

Browning, Chiappori, and Lewbel (2013) identify their model by assuming that the individual demand functions of singles and couple members are the same controlling for taste shifters and gender. Browning, Chiappori, and Lewbel (2013) prove that under these conditions a sharing rule $\eta(x,\boldsymbol{p})$ and Barten scales $\boldsymbol{\pi}$ are identified. Moreover, in their empirical application they are able to estimate a sharing rule and Barten scales for a system of (exclusively) non-assignable goods.

In general the HCIP assumption can be expressed as follows: Assignable goods are private goods and $w_g^{cf} = w_g^{sf}(\eta(x,\boldsymbol{p})x,\boldsymbol{\pi})$ and $w_g^{cm} = w_g^{sm}((1-\eta(x,\boldsymbol{p}))x,\boldsymbol{\pi})$ for non-assignable goods. In words, individual demand functions of singles and couple members for non-assignable goods are the same controlling for taste shifters and gender. Demand functions for assignable goods are allowed to depend on household composition in more general ways. In general, some of the parameters that partial HCIP assumes equal also appear in the assignable goods demand functions.[13] However, as long as there is more than one assignable good there will be some preference parameters unaffected by the partial HCIP assumption. The HCIP assumption only restricts preference parameters that do not exclusively appear in assignable goods budget shares. If there are at least two assignable goods then the assumption that assignable goods are private goods ensures that at least one such parameter exist. If there is only one assignable good then the partial HCIP and full HCIP assumption are the same. The implication of partial HCIP is that a single person facing $(x, \boldsymbol{p})$ and a couple member facing $(\eta^k x, \boldsymbol{\pi})$ will allocate the same shares of their individual budget, given by equations (2.8) and (2.9), to each non-assignable good and to total assignable goods. However, they allocate expenditure among assignable goods differently.

Identification follows from the proof of Browning, Chiappori, and Lewbel (2013). If expenditure shares and economies of scale can be identified from a group of non-assignable goods, then this is still the case if a group of private assignable goods is added. Moreover since the expenditure shares and economies of scale are identified from non-assignable goods, variation in observed household level budget shares of assignable goods can be used to identify the individual budget shares $w_g^k(\eta^k(x, \boldsymbol{p})x, \boldsymbol{\pi})$ for assignable goods.

2.3.3 Implementation of SAT

We implement a version of the SAT assumption proposed by Dunbar, Lewbel, and Pendakur (2013). Consider the individual budget shares given by

$$w_g^k = \psi_{g,c}^k + \psi_{g,z}^k \boldsymbol{z}^k + \beta_{g,c}^k \ln x + \boldsymbol{\beta}_{g,z}^{k\prime} \boldsymbol{z}^k \ln x, \tag{2.10}$$

for $k = sf, sm, cf, cm$. The HCIP budget shares of equation (2.4) fit this format with $\psi_{g,c}^k = (\alpha_{g,c}^k - \beta_{g,c}^k \ln a^k(\boldsymbol{p}, \boldsymbol{z}^k))$, $\psi_{g,z}^k = (\alpha_{g,z}^k - \beta_{g,z}^k \ln a^k(\boldsymbol{p}, \boldsymbol{z}^k))$ if the parametric model is given by equation (2.2).

In the system of linear Engel curves in equation (2.10), SAT imposes that the slope parameters are household composition independent. SAT is implemented as $\beta_g^{cf}(\boldsymbol{z}^{cf}) = \beta_g^{sf}(\boldsymbol{z}^{cf})$ and $\beta_g^{cm}(\boldsymbol{z}^{cm}) = \beta_g^{sm}(\boldsymbol{z}^{cm})$ for all goods.[14] The

[13] We thank an anonymous referee for pointing out that in a context with price variation not all parameters exclusively appear in either non-assignable goods or assignable goods budget shares. Even without price variation some parameters of the simplified AIDS model appear in all demand functions because they are part of an expenditure deflator.

[14] As in Dunbar, Lewbel, and Pendakur (2013) we do not allow η to depend on total

unrestricted intercept parameters can pick up household composition dependence of preferences and economies of scale (since ψ parameters depend on the price vector). The corresponding system of household level budget shares is given by equations (2.5), (2.6), (2.7) and (2.10). We use this system to estimate $\psi^k_{g,c}$, $\psi^k_{g,z}$, $\beta^k_{g,c}$ and $\beta^k_{g,z}$. Furthermore, we test whether the intercept parameters $\psi^k_{g,c}$, $\psi^k_{g,z}$ are household composition independent.

Dunbar, Lewbel, and Pendakur (2013) propose two ways of weakening the SAT assumption. First, the equal slope restriction can be implemented only for low expenditure households. We could in theory do the same for the partial HCIP assumption. Preliminary analysis revealed that neither of these models is well identified in our dataset. We therefore compare SAT and partial HCIP when implemented for all households. Second, SAT could be weakened by only restricting the slope parameters of assignable goods. We choose not to weaken the SAT assumption in order to maintain comparability with Dunbar, Lewbel, and Pendakur (2013).[15]

2.3.4 Estimation

The collective model described in this section can be estimated based on the system of linear Engel scales for singles given by equation (2.4) and the system for couples given by equations (2.5), (2.6) and (2.7). The HCIP assumption imposes restrictions across systems. It is therefore more efficient to estimate the systems jointly than to estimate the singles and couples system sequentially. We follow Browning, Chiappori, and Lewbel (2013) in that the we minimize the sum of the GMM criterion functions for the systems of Engel scales of singles and couples. Household income (net of taxes) is used as an instrument for total household expenditure. Standard errors are clustered at the household level to correct for the correlation between error terms of households observed in multiple waves.

When estimating the systems of Engel scales, we exclude one budget share from the system of single men and single women. The preference

expenditure. Otherwise, the same variables appear in the sharing rule for SAT and partial HCIP.

[15]Dunbar, Lewbel, and Pendakur (2013) use a system of 1 assignable good per household member and one non-assignable good. Each household member has a system of individual budget shares over their assignable good and the non-assignable good. These individual budget shares need to add up. It is therefore not possible to only restrict the slope of the assignable good.

parameters from the excluded budget share are recovered by imposing the adding up restrictions (see Barten (1969)). We also exclude one budget share of men in couples and one budget share of women in couples. The reason is that we need couple members' unobserved individual budget shares, given in equation (2.5) and (2.6), to add up as well.[16] Hence we impose 8 restrictions per household type and gender for a total of 32 restrictions.

The estimation strategy consists of three steps. First, the singles system is estimated by GMM using an identity weighting matrix. Second, we minimize the sum of the GMM criterion functions for the singles system and the couples system. An identity weighting matrix is used for the couples system, while the optimal weighting matrix is used for the singles system (based on the residuals from the first step). This step produces consistent estimates of couple exclusive parameters. Furthermore, we obtain residuals for the couples system. Finally, we estimate the two systems jointly once more using the optimal weighting matrices (based on the second step residuals). In each step we impose the partial HCIP constraints explicitly. Estimation is performed with Matlab's "fmincon" command using an interior point algorithm.

The joint system is non-linear in parameters. To address the possibility of ending up in the local but not global minimum we use the global search algorithm available in Matlab's global optimization toolbox. The global search algorithm can not guarantee that we find the global minimum. However, it at least informs us of the presence of other local minima. Furthermore, the lowest local minimum we find can be found from various starting points in the parameter space. In fact a majority of the starting points considered lead to the lowest minimum.

2.3.5 Indifference scales

Indifference scales in the spirit of Browning, Chiappori, and Lewbel (2013) are the share of household expenditure that a specific household member needs as disposable income to make him/herself as well off in a single person household as he/she is in the multiple person household. A member of a couple is indifferent between being part of a couple households with expenditure x and a single person household with expenditure x_*^{sf} if he/she can attain

[16] In a model with full household composition independence of preferences the adding up restrictions for singles guarantee adding up for couple members. In our model the adding up restrictions for couple members need to be imposed.

the same indifference curve. In mathematical terms we solve

$$V^{cf}(x_*^{sf}, \boldsymbol{p}, \boldsymbol{z}^{cf}) = V^{cf}(\eta^{cf} x, \boldsymbol{\pi}, \boldsymbol{z}^{cf}) \tag{2.11}$$

for x_*^{sf}, which we will refer to as indifference expenditure. Indifference scales equal x_*^{sf}/x for women in couples and x_*^{cm}/x for men in couples. It may not be immediately clear why V^{cf} should appear on both sides of equation (2.11). Note that one of the alternatives would be to solve $V^{sf}(x_*^{sf}, \boldsymbol{p}, \boldsymbol{z}^{cf}) = V^{cf}(\eta^{k} x, \boldsymbol{\pi}, \boldsymbol{z}^{cf})$. However as Browning, Chiappori, and Lewbel (2013) argue, this formulation implies an interpersonal utility comparison. We would need to assume that $V^{sf}(x_*^{sf}, \boldsymbol{p}, \boldsymbol{z}^{cf})$ and $V^{cf}(\eta^{k} x, \boldsymbol{\pi}, \boldsymbol{z}^{cf})$ are cardinally comparable. A valid alternative to equation (2.11) is to solve $V^{sf}(x_*^{sf}, \boldsymbol{p}, \boldsymbol{z}^{cf}) = V^{sf}(\eta^{k} x, \boldsymbol{\pi}, \boldsymbol{z}^{cf})$. However, in our model there is no practical difference between these formulations.[17] We use the solution to equation (2.11) to calculate indifference scales.

Note that when prices are normalized to 1 in equation (2.11) we have

$$\ln a^{sf} = \alpha_0, \qquad b^{sf} = 1,$$
$$\ln a^{cf}(\boldsymbol{z}^{cf}) = \alpha_0 + \sum_{i=G_A+1}^{G} \alpha_i^{cf}(\boldsymbol{z}^{cf}) \ln \pi, \qquad b^{cf}(\boldsymbol{z}^{cf}) = \prod_{i=G_A+1}^{G} d^{\beta_i(\boldsymbol{z}^{cf})}.$$

The left-hand side of equation (2.11) is given by

$$V^{cf}(x_*^{sf}, \boldsymbol{z}^{cf}) = \ln x_*^{sf} - \alpha_0, \tag{2.12}$$

for $k = cf, cm$ and the right-hand side of equation (2.11) is given by

$$V^{cf}(x_*^{sf}, \boldsymbol{z}^{cf}) = \frac{\ln \eta^{cf} x - \ln a^{cf}(\boldsymbol{z}^{cf})}{b^{cf}(\boldsymbol{z}^{cf})}. \tag{2.13}$$

Substituting equation (2.12) and (2.13) into equation (2.11), we can find a

[17]The partial HCIP assumption explains why there is no difference. The assumption ensures the share devoted to non-assignable goods for any given level of effective expenditure is the same for either set of preferences. Under the Engel scale assumption the budget share of non-assignables is the only preference based factor affecting indifference scales. If Barten scales are used instead then the allocation between non-assignable goods matters. However, this allocation is also fixed by equal preferences assumption.

solution for (log) indifference expenditure

$$\ln(x_*^{sf}) = \frac{\ln \eta^{cf} x - \sum_{i=G_A+1}^{G} \alpha_i^{cf}(\boldsymbol{z}^{cf}) \ln \pi}{b^{cf}(\boldsymbol{z}^{cf})} + \left(1 - \frac{1}{b^{cf}(\boldsymbol{z}^{cf})}\right)\alpha_0, \quad (2.14)$$

and for (log) indifference scales

$$\ln\left(\frac{x_*^{sf}}{x}\right) = \frac{\ln \eta^{cf} - \sum_{i=G_A+1}^{G} \alpha_i^{cf}(\boldsymbol{z}^{cf}) \ln \pi}{b^{cf}(\boldsymbol{z}^{cf})} + \left(\frac{1}{b^{cf}(\boldsymbol{z}^{cf})} - 1\right)(\ln x - \alpha_0). \quad (2.15)$$

We can calculate indifference scales based on (the exponential function of) equation (2.15). We can apply the same procedure to find the indifference scales for men.

2.4 Results

2.4.1 Structural parameters and preference changes

For a discussion of endogeneity and instrument relevance see Appendix C. Structural parameter estimates are reported in Tables 2.3, 2.4, 2.5 and 2.6. Here we test several hypotheses about these structural parameters. Note that the partial HCIP model imposes the restrictions

$$\begin{aligned}
\alpha_g^{cf}(\boldsymbol{z}^{cf}) &= \alpha_g^{sf}(\boldsymbol{z}^{cf}) \\
\beta_g^{cf}(\boldsymbol{z}^{cf}) &= \beta_g^{sf}(\boldsymbol{z}^{cf}) \\
\alpha_g^{cm}(\boldsymbol{z}^{cm}) &= \alpha_g^{sm}(\boldsymbol{z}^{cm}) \\
\beta_g^{cm}(\boldsymbol{z}^{cm}) &= \beta_g^{sm}(\boldsymbol{z}^{cm})
\end{aligned}$$

on equations (2.5), (2.6) and (2.7) for $g = 2 \cdot G_A + 1, \ldots, G_H$. The assumptions tested below impose additional restrictions.

First, we test the hypothesis that all the allocation preferences of men and women are equal. The partial HCIP model is estimated with the additional restriction that single men have the same preferences as single women $\alpha_g^{sm}(\boldsymbol{z}^{sm}) = \alpha_g^{sf}(\boldsymbol{z}^{sm})$, $\beta_g^{sm}(\boldsymbol{z}^{sm}) = \beta_g^{sf}(\boldsymbol{z}^{sm})$ and men in couples have the same preferences as women in couples $\alpha_g^{cm}(\boldsymbol{z}^{cm}) = \alpha_g^{cf}(\boldsymbol{z}^{cm})$, $\beta_g^{cm}(\boldsymbol{z}^{cm}) =$

$\beta_g^{cf}(\boldsymbol{z}^{cm})$. In total, we impose 72 additional restrictions.[18] We find a Likelihood Ratio (LR) χ^2 statistic of 438.87, which is significant at the 1% level. The test result suggests that preferences of men and women towards allocating a given budget differ significantly. This underlines the importance of using a collective approach to study household behavior. Collective models allow the different preferences of household members to play a role in decision making.

We now test our main hypothesis. The null hypothesis is that all preference parameters of singles and members of couples of the same gender are equal. The alternative is the model estimated under partial HCIP. We equate the preference parameters of singles and couple members, insofar as not already equated by the partial HCIP assumption: $\alpha_g^{cf}(\boldsymbol{z}^{cf}) = \alpha_g^{sf}(\boldsymbol{z}^{cf})$, $\beta_g^{cf}(\boldsymbol{z}^{cf}) = \beta_g^{sf}(\boldsymbol{z}^{cf})$, $\alpha_g^{cm}(\boldsymbol{z}^{cm}) = \alpha_g^{sm}(\boldsymbol{z}^{cm})$, $\beta_g^{cm}(\boldsymbol{z}^{cm}) = \beta_g^{sm}(\boldsymbol{z}^{cm})$ for $g = 1, \ldots, 2 \cdot G_A$. This amounts to 32 additional restrictions with respect to the partial HCIP model.[19] The χ^2 statistic for the HCIP hypothesis is 156.78. With 32 degrees of freedom the p-value is substantially smaller than conventional levels of significance. We thus reject the household composition independence hypothesis. We also test full household composition independence of intercept and slope parameters against the SAT specification.[20] The SAT specification is given by the assumption that $\beta_g^{cf}(\boldsymbol{z}^{cf}) = \beta_g^{sf}(\boldsymbol{z}^{cf})$ and $\beta_g^{cf}(\boldsymbol{z}^{cf}) = \beta_g^{sf}(\boldsymbol{z}^{cf})$ for $G = 1, \ldots, G$ in equation (2.10). Full HCIP imposes the additional restrictions $\psi_g^{cf}(\boldsymbol{z}^{cf}) = \psi_g^{sf}(\boldsymbol{z}^{cf})$ and $\psi_g^{cf}(\boldsymbol{z}^{cf}) = \psi_g^{sf}(\boldsymbol{z}^{cf})$ for $G = 1, \ldots, G$. We find a χ^2 statistics of 475.03. With 64 degrees of freedom we reject this hypothesis. Note that this result could be explained by either household composition dependent preferences or the existence of scale economies. At best this test provides supportive evidence that HCIP should be rejected. In contrast to Bargain and Donni (2012) we find that preferences of singles and couple members are significantly different.[21] Individuals

[18]We have a total of 88 preference parameters by gender. We explicitly equate all but 16 parameters across gender. The remaining 16 parameters (8 for singles and 8 for couple members) are equated automatically through the adding up restrictions.

[19]We restrict 8 preference parameters in each of two assignable good budget shares for both women and men. The parameters in third assignable good budget share are restricted through the adding up restriction.

[20]Full results for SAT are available upon request.

[21]Bargain and Donni (2012) are able to reject the equal preferences assumption at the 5% level but not the 1%. They have a sample of reasonable size and conclude that the assumption is not rejected. Our sample is of a similar size, but we find stronger evidence against the null hypothesis of equal preferences.

in single person households do not seem to have the same preferences towards allocating a given budget as their same gender counterparts in couples. Section 2.4.3 discusses the implied behavioral differences between single persons and couple members of the same gender.

A final issue that can be addressed with the structural preference parameter estimates is the independence of base assumption. In our model indifference scales are independent of base expenditures (independent of x) only if the sharing rule coefficient on total expenditure is zero, see equation (2.15). Furthermore, we require that $b^k(\boldsymbol{z}^k) = 1$ for $k = cf, cm$, which implies that $\sum_{i=G_A+1}^{G} \beta_{i,c}^k = 0$ and $\sum_{i=G_A+1}^{G} \boldsymbol{\beta}_{i,z}^k = \mathbf{0}$ hold jointly. The χ^2 statistic for this set of restrictions is 358.40. With 55 degrees of freedom we find a p-value substantially below 0.01. We therefore reject the independence of base assumption. The fact that we do not need to make the independence of base assumption(s) in order to identify our collective model may help explain why we find significant evidence against preference equality whereas Bargain and Donni (2012), who make the independence of base assumption, find weaker evidence.

2.4.2 Economies of scale and sharing

Table 2.7 reports the results for the sharing rule and economies of scale. We estimate that the Engel scale for non-assignable good consumption (π^N) equals 0.65. The 95% confidence interval for the effective price is 0.62 to 0.68. On average a couple spends 79% of its budget on non-assignable goods. This hypothetical couple would therefore need to spend $21\% + 79\%/0.65 \approx 143\%$ of their household budget in order to privately purchase their current consumption bundle when they are living apart. This figure lies between the square root scale (1.41) and the OECD-modified equivalence scale (1.50) from Hagenaars et al. (1994). Browning, Chiappori, and Lewbel (2013) refer to $143\% - 100\% = 43\%$ as the relative economies of scale in consumption. The best available comparison is with Cherchye, de Rock, and Vermeulen (2012a) and Browning, Chiappori, and Lewbel (2013). The model underlying Cherchye, de Rock, and Vermeulen (2012a) and this paper is that of Browning, Chiappori, and Lewbel (2013). However, Cherchye, de Rock, and Vermeulen (2012a) and Browning, Chiappori, and Lewbel (2013) maintain the HCIP assumption. Browning, Chiappori, and Lewbel (2013) find higher relative scale economies of 52% in their preferred specification. The

Table 2.3: Single women's parameters

Parameter	Housing	Utilities	Transport	Insurance	Food at home	Leisure	Clothing	Personal care
$\alpha_{g,0}$	0.5061**	0.1716**	0.0037	0.1131**	0.1144**	0.0459**	0.0281**	0.0170**
	(0.0205)	(0.0092)	(0.0065)	(0.0101)	(0.0146)	(0.0109)	(0.0056)	(0.0037)
$\alpha_{g,age}$	0.0380**	0.0197**	-0.0074**	0.0018	-0.0093	-0.0259**	-0.0128**	-0.0040*
	(0.0086)	(0.0043)	(0.0028)	(0.0051)	(0.0066)	(0.0047)	(0.0030)	(0.0017)
$\alpha_{g,educ}$	-0.0598*	-0.0455**	0.0001	0.0182	0.0148	0.0478**	0.0232*	0.0011
	(0.0282)	(0.0123)	(0.0094)	(0.0141)	(0.0197)	(0.0174)	(0.0100)	(0.0059)
$\alpha_{g,home}$	-0.1731**	0.0525**	0.0691**	0.0081	0.0666*	-0.0254	-0.0029	0.0051
	(0.0360)	(0.0151)	(0.0123)	(0.0173)	(0.0270)	(0.0211)	(0.0136)	(0.0090)
$\beta_{g,0}$	-0.2725**	-0.0612**	0.1032**	0.0259	0.0842**	0.0682**	0.0347**	0.0175*
	(0.0352)	(0.0154)	(0.0125)	(0.0174)	(0.0288)	(0.0205)	(0.0123)	(0.0080)
$\beta_{g,age}$	-0.0940**	-0.0051	0.0017	0.0107	0.0407**	0.0291**	0.0094	0.0077*
	(0.0138)	(0.0060)	(0.0047)	(0.0079)	(0.0109)	(0.0074)	(0.0054)	(0.0032)
$\beta_{g,educ}$	0.1188**	0.0630**	-0.0049	-0.0326	-0.0380	-0.0623*	-0.0377*	-0.0062
	(0.0381)	(0.0158)	(0.0128)	(0.0187)	(0.0354)	(0.0274)	(0.0168)	(0.0110)
$\beta_{g,home}$	0.2707**	-0.0785**	-0.1023**	-0.0183	-0.1129**	0.0213	0.0246	-0.0046
	(0.0486)	(0.0207)	(0.0175)	(0.0231)	(0.0378)	(0.0295)	(0.0188)	(0.0123)

Clustered standard errors in parentheses, $^{**}p < 0.01$ $^{*}p < 0.05$.

Table 2.4: Single men's parameters

Parameter	Housing	Utilities	Transport	Insurance	Food at home	Leisure	Clothing	Personal care
$\alpha_{g,0}$	0.3536**	0.0965**	0.0051	0.1209**	0.2839**	0.0896**	0.0327**	0.0178**
	(0.0272)	(0.0115)	(0.0105)	(0.0147)	(0.0344)	(0.0263)	(0.0106)	(0.0039)
$\alpha_{g,age}$	-0.0191	0.0048	-0.0058	0.0479**	0.0375*	-0.0543**	-0.0106*	-0.0004
	(0.0139)	(0.0059)	(0.0059)	(0.0087)	(0.0146)	(0.0134)	(0.0048)	(0.0024)
$\alpha_{g,educ}$	-0.1152**	-0.0138	-0.0041	0.1043**	0.0090	0.0108	0.0086	0.0004
	(0.0317)	(0.0131)	(0.0140)	(0.0199)	(0.0268)	(0.0261)	(0.0100)	(0.0053)
$\alpha_{g,home}$	-0.2009**	0.0484**	0.0513**	0.0644**	-0.1643**	0.1820**	0.0114	0.0076
	(0.0432)	(0.0166)	(0.0178)	(0.0215)	(0.0436)	(0.0413)	(0.0139)	(0.0052)
$\beta_{g,0}$	0.0277	0.0535*	0.1140**	-0.0060	-0.2314**	0.0492	-0.0052	-0.0018
	(0.0579)	(0.0234)	(0.0245)	(0.0305)	(0.0712)	(0.0570)	(0.0221)	(0.0081)
$\beta_{g,age}$	-0.0078	0.0084	0.0075	-0.0743**	-0.0391	0.0855**	0.0190*	0.0008
	(0.0261)	(0.0096)	(0.0111)	(0.0162)	(0.0264)	(0.0254)	(0.0089)	(0.0045)
$\beta_{g,educ}$	0.1405**	-0.0073	-0.0025	-0.1659**	0.0445	-0.0259	0.0160	0.0006
	(0.0512)	(0.0189)	(0.0228)	(0.0300)	(0.0431)	(0.0441)	(0.0173)	(0.0081)
$\beta_{g,home}$	0.1987**	-0.0917**	-0.0758*	-0.0777*	0.2507**	-0.1985**	0.0037	-0.0095
	(0.0733)	(0.0275)	(0.0326)	(0.0353)	(0.0768)	(0.0678)	(0.0243)	(0.0087)

Clustered standard errors in parentheses, $^{**}p < 0.01$ $^{*}p < 0.05$.

Table 2.5: Women in couples parameters

Parameter	Leisure	Clothing	Personal care
$\alpha_{g,0}$	0.0050	0.0602**	0.0259
	(0.0221)	(0.0119)	(0.0279)
$\alpha_{g,age}$	-0.0352**	-0.0035	-0.0040
	(0.0095)	(0.0060)	(0.0127)
$\alpha_{g,educ}$	0.1403**	-0.0132	-0.0550
	(0.0312)	(0.0140)	(0.0411)
$\alpha_{g,home}$	0.0066	-0.0306*	0.0008
	(0.0274)	(0.0143)	(0.0425)
$\beta_{g,0}$	0.1247**	-0.0123	0.0079
	(0.0283)	(0.0141)	(0.0413)
$\beta_{g,age}$	0.0376**	0.0025	0.0060
	(0.0101)	(0.0063)	(0.0157)
$\beta_{g,educ}$	-0.1506**	0.0018	0.0425
	(0.0317)	(0.0141)	(0.0503)
$\beta_{g,home}$	-0.0002	0.0458**	-0.0044
	(0.0306)	(0.0165)	(0.0525)

Clustered standard errors in parentheses, $^{**}p < 0.01$ $^{*}p < 0.05$.

comparatively high economies of scale in Browning, Chiappori, and Lewbel (2013) are surprising. Browning, Chiappori, and Lewbel (2013) do not include housing and utilities in their demand system, two goods which have large budget shares and (presumably) high economies of scale. The relative scale economies found by Cherchye, de Rock, and Vermeulen (2012a) for the Dutch elderly population are close to ours at 38%.[22] We find it reassuring that there are no large differences in economies of scale between working age and elderly individuals in the Netherlands.

The wife's predicted share has an average of 58% and a standard deviation of 3% in our sample. The minimum and maximum expenditure shares are respectively 48% and 69%. The average expenditure share found here is lower than the 63% expenditure share found in both Browning, Chiappori, and

[22]Cherchye, de Rock, and Vermeulen (2012a) are able to identify Barten scales. The lowest effective prices they find are for housing, transport and energy, to which elderly households appear to assign a slightly larger share than working age households. However, they find relatively low economies of scale overall. Their lowest effective price (housing) is at 0.68 higher than our overall effective price for non-assignable goods.

Table 2.6: Men in couples parameters

Parameter	Leisure	Clothing	Personal care
$\alpha_{g,0}$	0.2213**	-0.0216**	-0.0597
	(0.0218)	(0.0070)	(0.0340)
$\alpha_{g,age}$	-0.0302**	-0.0173**	-0.0178
	(0.0102)	(0.0040)	(0.0160)
$\alpha_{g,educ}$	-0.0746**	0.0482**	0.0462
	(0.0258)	(0.0088)	(0.0357)
$\alpha_{g,home}$	-0.0263	0.1079**	0.1195*
	(0.0247)	(0.0098)	(0.0488)
$\beta_{g,0}$	-0.2174**	0.1236**	0.1359
	(0.0528)	(0.0137)	(0.0771)
$\beta_{g,age}$	0.0475**	0.0266**	0.0312
	(0.0165)	(0.0062)	(0.0282)
$\beta_{g,educ}$	0.1248**	-0.0732**	-0.0610
	(0.0383)	(0.0136)	(0.0538)
$\beta_{g,home}$	0.1703**	-0.1727**	-0.2019*
	(0.0534)	(0.0166)	(0.0848)

Clustered standard errors in parentheses, $^{**}p < 0.01$ $^{*}p < 0.05$.

Lewbel (2013) for Canada and Cherchye, de Rock, and Vermeulen (2012a) for the elderly population of the Netherlands. We confirm earlier findings that the wife has more control over a couple's expenditure pattern than the husband. In only 12 out of 847 cases do we predict that the husband has more influence on expenditure than the wife. The wife's average share of expenditure varies little across age groups (by either wife's or husband's age). The average share is respectively 61%, 58%, 57% and 55% in the household expenditure quartiles.

Turning to the sharing rule variables we see that the higher education dummies and household expenditure stand out. Highly educated women (who completed a degree in higher vocational or university level education) control a 4.7 percentage point higher share than lower educated women. The corresponding effect of husband's education on the husband's share is weaker at 1.8 percentage point and significant only at the 10% level. Note that we control for relative income and total expenditure. The education effects do not reflect the effect of education on income and subsequently on bargaining

Table 2.7: Sharing rule and economies of scale

	Param.	Std.Err.	AME on share
Constant	0.2900**	0.0687	
Wife-Husband age difference	0.0002	0.0041	0.0000
Wife's income share	0.0986	0.0773	0.0238
Married	0.0301	0.0434	0.0073
Homeowner	-0.0529	0.0622	-0.0128
Log(HH expenditure)	-0.3293*	0.1357	-0.0813
Wife higher education	0.1946**	0.0602	0.0469
Husband higher education	-0.0739	0.0425	-0.0180
Economies of scale			
Effective price	0.6492**	0.0102	

Clustered standard errors in parentheses, $^{**}p < 0.01$ $^{*}p < 0.05$. AME means average marginal effect.

power. In contrast to earlier studies, we find a significant negative effect of household expenditure on the wife's share of expenditure. A unit increase in the logarithm of household expenditure is associated with an 8 percentage point lower share of expenditure for the wife.

We can see the influence of weakening the HCIP assumption by comparing the partial HCIP results to the results found for full HCIP.[23] In the full HCIP model the Engel scale for non-assignable goods is 52%. Relative scale economies are $22\% + 78\%/0.52 \approx 171\%$. Economies of scale are considerably larger than implied by the OECD-modified equivalence scales and our partial HCIP results. The wife's share of expenditures is on average 53% for full HCIP. The full HCIP assumption thus leads to overestimation of economies of scale and underestimation of inequality in the household.

We find a Hansen-Sargan J statistic for partial HCIP equal to 218.42. We have 282 moment conditions and 153 free parameters. With 129 degrees of freedom we find a p-value below 0.01 and reject the over-identifying restrictions. Such a finding is common in the demand system literature, see e.g. Browning and Meghir (1991), Browning, Bourguignon, et al. (1994) and Browning, Chiappori, and Lewbel (2013). Essentially we jointly test restrictions imposed by utility maximization, the collective household model

[23]The results for full HCIP are available on request.

and our identifying assumption. For example, if individual decisions are better described by bounded rationality than by utility maximization then we would expect the over-identifying restrictions to be rejected. Alternatively, the test result may reflect that the partial HCIP assumption on preferences is rejected. In other words, it is possible that we need a model with full household composition dependence of preferences. The Hansen-Sargan test unfortunately does not suggest a specific improvement to the model.

2.4.3 Allocation differences decomposed

In Figure 2.1 we present a visual decomposition of single-couple member allocation differences. The lines represent the predicted shares of the individual budget as a function of the individual budget (ηx). We focus on the budget shares of low educated, home owning women aged 49 (the mean). The solid line corresponds to a single woman whereas the dashed line corresponds to a woman in a couple. The dotted line corresponds to a woman with the preferences of a couple member who does not enjoy economies of scale. It is the budget share of a woman in a couple evaluated at market prices.

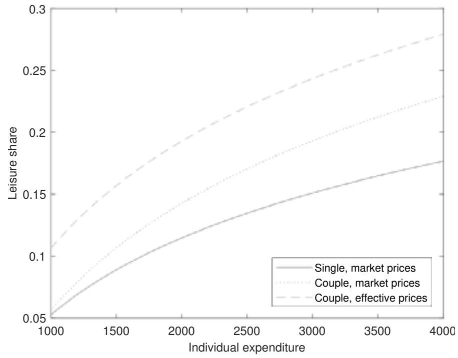
The influence of preference differences is represented by the vertical distance between the solid (single at market prices) and dotted line (couple at market prices). We allow both the intercept parameter (α) and slope parameter (β) of our Engel curves to be household composition dependent. We therefore observe both a vertical shift and a change in curvature of the budget share. Preference differences induce couple members to allocate a larger share of the budget to leisure than singles at any level of expenditure.[24] The differences widen at higher levels of expenditure. The opposite effect can be observed for the clothing budget share. Personal care expenditures initially rise as a share of the budget and then fall at higher levels of expenditure.

The effect of economies of scale, at a given preference set, is to make couple members behave as if they have a larger budget. This effect is visualized by a horizontal shift from the dotted (couple at market prices) to the dashed line (couple at effective prices). The horizontal shift follows from the fact that the effective expenditure term in equation (2.8) (the term in square brackets) is decreasing in the effective price of non-assignable goods π. A leftward shifts indicates a luxury good and a rightward shift indicates a necessity. We predict a greater share for leisure, clothing and personal care

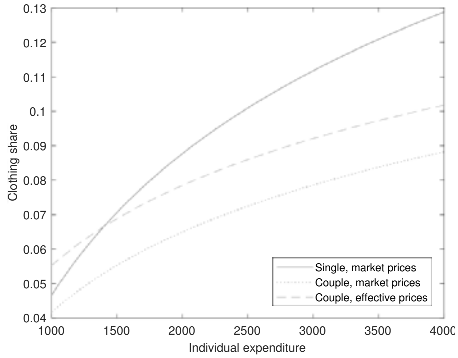
[24] Technically, any expenditure level above the subsistence level.

Figure 2.1: Predicted budget shares

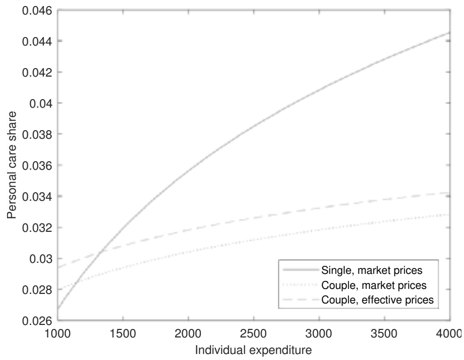
(a) Leisure



(b) Clothing



(c) Personal care



due to economies of scale since each of these goods is classified as a luxury.[25]

The decomposition of predicted allocation differences shows that the role of preference differences is substantial compared to the role of economies of scale. This result is not specific to low educated, home owning women. Household composition dependence of preferences seems to enrich the model considerably.

2.4.4 Indifference scales

In this section we take a closer look at the indifference scales implied by our results. On average women in couples need 81% and men need 59% of total household expenditure to be materially as well off when living alone. Table 2.8 presents average indifference scales per household expenditure decile for our sample of couples.

An indifference scale is determined mainly by an individual's expenditure share and their preference for non-assignable goods. The latter determines what share of their budget an individual devotes to non-assignable goods. By assumption couple members only enjoy economies of scale in the consumption of non-assignable goods. Indifference scales compensate for these lost economies of scale. Hence they are larger when the budget share devoted to non-assignable goods is larger. The 22 percentage point difference between female and male average indifference scales reflects womens' larger expenditure shares and their stronger preference for non-assignable goods. As household expenditure increases this difference shrinks for two reasons. First, expenditure shares of women decrease while those of men increase. Second, women develop a weaker taste for non-assignable goods as household expenditure increases while the opposite is true for men.

A couple on average needs 141% of their household expenditure when living alone to be materially as well off as they are as part of a couple. This can be interpreted as a measure of economies of scale at the household level. Interestingly this measure is virtually the same above the fourth expenditure decile. As expenditure increases the expenditure share of the husband increases. The husband has a weaker preference for non-assignable goods than his spouse. However, husbands develop a stronger taste for non-assignable goods as expenditure increases. Initially the net effect on the household level

[25] For younger individuals all non-assignable goods eventually become necessities, see the β parameters in Tables 2.3, 2.4, 2.5 and 2.6.

budget share of non-assignable goods is negative. After the fourth decile, the two effects virtually cancel each other out.

Table 2.8: Mean indifference scales by household expenditure decile

Decile	1	2	3	4	5	6	7	8	9	10
Wife	0.91	0.87	0.84	0.83	0.81	0.80	0.79	0.79	0.77	0.73
Husband	0.52	0.56	0.58	0.58	0.59	0.60	0.61	0.61	0.63	0.67

The indifference scales calculated in this paper may be compared to those of Browning, Chiappori, and Lewbel (2013) for Canada and Cherchye, de Rock, and Vermeulen (2012a) for the elderly population of the Netherlands and our full HCIP results. Cherchye, de Rock, and Vermeulen (2012a) find that average indifference scales for female (male) Dutch retirees vary between 76% (45%) and 83% (42%) for respectively the first and fourth household expenditure quartile. Browning, Chiappori, and Lewbel (2013) find higher indifference scales for women (83%) and men (66%). Our indifference scales lie between their estimates primarily because our economies of scale measure lies between theirs. The indifference scales of women and men are closer to each other in our study due to more equal sharing. Furthermore, average indifference scales in the full HCIP model are equal to 87% and 79%. For men imposing full HCIP thus leads to a 20 percentage point increase in average indifference scales.

We now check whether the average indifference scales calculated in this paper are numerically close to equivalence scales used in publications by Statistics Netherlands (CBS) and The Netherlands Institute for Social Research (SCP). In a recent publication about poverty in the Netherlands SCP and CBS (2014), the institutes use an equivalence scale for two adult households relative to a single person households of 1.37. This implies that a single person needs a share of $1/1.37 = 0.73$ to be equally well off as a couple household. The two members of a couple would jointly need 1.46 for the same purpose. The indifference scales above instead imply that on average men need a share of 0.59, women a share of 0.81 and a couple jointly needs a share of 1.41 of household expenditure when living apart. Equivalence scales overestimate the latter share by only 5 percentage points relative to indifference scales. However, equivalence scales underestimate the average share of household expenditure needed by women (men) by 8 (14) percentage points. This large gender gap reflects intra-household inequality. Equivalence scales perform poorly because they ignore intra-household inequality.

Table 2.8 reveals that the CBS-SCP equivalence scale of 0.73 underestimates the needs (as singles) of 91% of women in our sample. Moreover, the needs of most men are overestimated. The needs of 39% of women and 79% of men are respectively underestimated and overestimated by more than 10% of their total household expenditure. Of particular concern is the group of working age women in the lower expenditure quartile. For women in the lower half of the household expenditure distribution the needs as singles is on average underestimated by 13% of their current household expenditure. This figure increases to almost 15% for women in the lowest expenditure quartile. Equivalence scales perform especially poorly for these groups because they do not vary with household expenditure.

2.4.5 Poverty lines

In the remainder of the section we use an analysis of the poverty rate to show the implications of replacing equivalence scales with indifference scales. We use information from SCP and CBS (2014) to show what our estimates imply about the level of poverty in the Netherlands. CBS and SCP use poverty lines that take the needs of a single person as the reference point. Poverty lines for multiple person households are derived from the singles poverty line by multiplying the latter by equivalence scales. For example SCP and CBS (2014) report a singles poverty line of x^s_{pov}=€1010, an equivalence scale for couples (relative to singles) of $E = 1.37$ and thus a couples poverty line of x^c_{pov} =€1390. This approach can be justified if the members of a couple with expenditure $x^c_{pov} = E \cdot x^s_{pov}$ are indifferent with living as single persons each with expenditure equal to x_{pov}. The approach above assumes that there is no intra-household inequality in couples. When there is intra-household inequality in couples we cannot be sure that couples with expenditure $x \geq x^c_{pov}$ will allocate this budget in such a way that both members are weakly better off than a single person with expenditure x^s_{pov}.

A poverty line that accounts for intra-household inequality can be constructed by starting from the indifference condition

$$V^{cf}(x^s_{pov}, \boldsymbol{p}, \boldsymbol{z}^{cf}) = V^{cf}(x^{cf}_*, \boldsymbol{\pi}, \boldsymbol{z}^{cf}). \tag{2.16}$$

In Section 2.4.4 we solved this condition for expenditure as a single person given a level of individual expenditure as a couple member. Here we solve the condition for individual expenditure as a couple member x_*^{cf} given expenditure as a single person at the poverty line x_{pov}^s. Taking roughly the same steps as in Section 2.4.4 we find

$$\ln x_*^{cf} = b^{cf}(\boldsymbol{z}^{cf}) \ln(x_{pov}^s) + \sum_{i=G_A+1}^{G} \alpha_i^{cf}(\boldsymbol{z}^{cf}) \ln \pi + \left(b^{cf}(\boldsymbol{z}^{cf}) - 1\right) \alpha_0, \quad (2.17)$$

We define what we call the naive couples poverty line as $x_{pov}^c = x_*^{cf} + x_*^{cm}$ where x_*^{cm} solves the male version of equation (2.17). The poverty line is naive in the sense that in practice couples do not choose the allocation $\eta^{cf} = x_*^{cf}/x_{pov}^c$ and $\eta^{cm} = x_*^{cm}/x_{pov}^c$ at the poverty line. With respect to the height of the poverty line this naive approach is the most conservative way of including intra-household inequality. In theory, the solutions for x_*^{cf} and x_*^{cm} can be used for individual level poverty analysis by comparing them to individual expenditure of couple members. Following the approach described above we find that women (men) need on average €694 (€731) as part of a couple to be as well off as they would be living alone at the poverty line of €1010.[26] The naive version of the couples poverty line is estimated at €1425. We therefore find a poverty line that is remarkably close to the €1390 poverty line used in SCP and CBS (2014). The naive poverty line would naturally predict a higher poverty rate than the poverty line from SCP and CBS (2014).

If we want to construct a more sophisticated poverty line then we need to impose that in addition to solving the two indifference conditions the unknowns $x_*^{cf} = \eta^{cf} x_{pov}^c$ and $x_*^{cm} = \eta^{cm} x_{pov}^c$ must satisfy the sharing rule we have estimated above. Note that this leaves the system underdetermined. We have two indifference conditions to solve but only one unknown x_{pov}^c. In other words, we cannot implement a specific sharing rule and keep both members exactly indifferent. We therefore replace equation (2.17) by

$$\ln x_*^{cf} \leq b^{cf}(\boldsymbol{z}^{cf}) \ln(x_{pov}^s) + \sum_{i=G_A+1}^{G} \alpha_i^{cf}(\boldsymbol{z}^{cf}) \ln \pi + \left(b^{cf}(\boldsymbol{z}^{cf}) - 1\right) \alpha_0,$$

[26] In theory, x_*^{cf} =€694 and x_*^{cm} =€731 can be used for individual level poverty analysis by comparing them to individual expenditure of couple members.

and/or do the same to the man's indifference condition.[27] A practical implementation is to start from the naive solution of x^c_{pov}, predict the expenditure shares at the naive solution $\eta^{cf} x^c_{pov}$ and $\eta^{cm} x^c_{pov}$ and then increase x^c_{pov} until both $\eta^{cf} x^c_{pov}$ and $\eta^{cm} x^c_{pov}$ are greater than or equal to the naive solutions x^{cf}_* and x^{cm}_*.[28] The sophisticated couples poverty line equals €1781. The higher poverty line results from the more stringent requirement that both members of the couples should be kept indifferent with living at the singles poverty line given the intra-household distribution at the poverty line.[29] Some people may see the intra-household distribution of resources as a private affair. They may argue that intra-household inequality should not be a consideration when constructing a poverty line. The naive poverty line is constructed in line with their views.

For households with expenditure between the naive and sophisticated poverty line at least one member is worse off than a single person at the poverty line given the households predicted intra-household distribution. The large difference between the poverty lines suggests that in a household level approach to poverty analysis there is substantial scope for misclassifying members of couples as out of poverty. We illustrate this by comparing income levels in the sample to the poverty line measures. In our sample just over 6% of couples have income below the naive poverty line and 16% of couples have income below the refined poverty line.

The naive and refined poverty line can be used together to obtain an upper bound on the number of individuals living in poverty. In most couples below the naive poverty line both members are in poverty. In couples close to the naive poverty line one member is not in poverty if the intra-household distribution is sufficiently unequal. In couples between the two poverty lines the intra-household distribution of resources ensures that one member is in poverty while the other is not. Therefore, an upper bound for the couple member poverty rate is given by $(2 \cdot 6\% + 15\% - 6\%)/2 = 10.5\%$ in our sample. An exact number can be found by predicting each couple member's

[27]If the inequality form of both conditions is used then we can find a poverty line by minimizing the squared distance between the left hand side and right side of equation (2.4.5) and its male equivalent with respect to x^c_{pov}.

[28]We found that η^{cf} is a decreasing function of household expenditure. We take this effect into account.

[29]The naive approach implies an intra-household distribution where men control 51% of expenditure while we estimate that men control about 41% of expenditure at the naive poverty line. The sophisticated couples poverty line therefore approximately equals €731/0.41.

individual budget and comparing it to the couple member poverty lines. This has the advantage that it produces a poverty rate by gender. We would predict that more men than women in couples live in poverty. The reason is that men in couples control a smaller share of expenditure than women in couples.

To demonstrate the potential bias induced in poverty analysis by using estimates based on full HCIP we have estimated poverty line measures for full HCIP. Due to stronger economies of scale in the full HCIP model couple member poverty lines drop to €577 for women and €599 for men. The poverty line for women decreases by €117, the poverty line of men decreases by €132, the naive couples poverty line decreases by €250 and the sophisticated couples poverty line decreases by €471. This implies that a substantial number of households are re-classified from poor to non-poor.

2.5 Conclusion

We have used a collective model of household consumption to explain the allocation of expenditure by singles and couples households. The model of Browning, Chiappori, and Lewbel (2013) allowed us to explain the variation in expenditure shares of a variety of goods with reference to three important factors. First, members of couples come to a division of resources between them that is not necessarily equal. We were able to exploit individual assignable goods expenditure data to partially observe a couple member's share of household expenditure. We combined data on assignable and non-assignable goods to estimate a sharing rule for total expenditure. On average the wife's share of consumption expenditure amounted to 58%, which is somewhat lower than in comparable studies. Second, we were able to include and estimate economies of scale in the consumption of (household level) non-assignable goods. We estimate that (due to economies of scale) couple member's effectively pay a 35% lower price than singles for non-assignable goods. Members of couples that split up would need to pay 43% more to jointly purchase the bundle of goods they purchased as a couple. Finally, we allowed singles and members of couples to have different sets of preferences. The analysis revealed that women and men have significantly different preferences towards the allocation of a budget. More importantly, we were able to reject the hypothesis that preferences of singles and members of couples are the same controlling for gender. We found strong evidence that singles and their same gender counterparts in couples have different preferences. As a consequence they would be observed to allocate their budget differently.

Based on the estimation results of our model we have constructed a set of indifference scales. The indifference scales depend on total expenditure, our estimate of economies of scale, and a number of individual and household background variables. We compared average indifference scales for the sample and relevant subgroups to earlier estimates and to equivalence scales that are used in practice. Indifference scales were on average equal to 81% of household expenditure for women and 59% for men. We find higher average indifference scales for men and women than those calculated by Cherchye, de Rock, and Vermeulen (2012a) for the elderly population of the Netherlands. We use similar categories of goods to Cherchye, de Rock, and Vermeulen (2012a). Indifferences scales are higher because we find stronger overall economies of scale than Cherchye, de Rock, and Vermeulen (2012a). The indifference scales we calculate are somewhat lower than those calculated by Browning, Chiappori, and Lewbel (2013) for Canada. The difference primarily reflects our lower estimate of economies of scale. Compared to the equivalence scales used by Statistics Netherlands (CBS) and The Netherlands Institute for Social Research (SCP), our indifference scales imply that women need a greater portion of household expenditure to be as well off as they were as a member of a couple. Men in couples need less expenditure than implied by the CBS-SCP equivalence scale. Our results suggest that the needs of 39% of women are underestimated by more than 10% of their total household expenditure. The problem is especially severe among the group of working age women in the lowest household expenditure quartile. The needs of this group are underestimated by more than 15% of their household expenditure. Strong underestimation of the needs of this group is particularly undesirable since this group is already relatively poor.

We have discussed the implications of these result for the analysis of poverty. Poverty lines that account for economies of scale in consumption and unequal preferences have been constructed for couples and couple members. The poverty lines for couples members can be used for policy design and evaluation purposes instead of the conventional couples poverty lines which are found by equivalence scaling single person poverty lines. Individual level (as opposed to household level) analysis is possible with the couple member poverty lines. The poverty line for couples is defined so as to allow the couple to keep both its members at least as well off when living in the couple as they are living alone at the singles poverty line. We calculate a naive and a sophisticated version. The naive version makes both members exactly indifferent for one specific intra-household distribution. The sophisticated version makes both members at least as well off given the actual intra-household distribution we predict holds at the poverty line. The naive poverty line for couples was estimated at €1425, slightly higher than the CBS-SCP couples poverty line (€1390). The sophisticated version was estimated at €1781. For households with expenditure between these poverty lines at least one member is worse off than a single person at the poverty line given the households predicted intra-household distribution. The large difference between the poverty lines suggests that in a household level approach to poverty analysis there is substantial scope for misclassifying members of couples as out of poverty. Furthermore, we show that imposing full household composition independence of preference can substantially bias estimates of poverty lines for couples downward.

The approach taken in this paper could be improved upon. Although we were able to identify Barten scales, the estimates of these scales were imprecise. We restricted Barten scales to a common value. The loss of fit from this restriction was very small. Nonetheless, this restriction affects the extent to which individuals can re-optimize after a household composition change. As a consequence indifference scales may be somewhat too high. A longer data set with relative price variation would help identify Barten scales. The model may also be extended by including children. This would allow us to explain the demand for child goods, the additional demand for non-child goods, and investigate whether preferences differ between couples with and without children. Chapter 4 addresses the latter issue. Finally, the model could be extended to include the labor supply decision. The current analysis is partial in the sense that it treats labor supply and income as exogenous. In reality total expenditure, labor supply and income are determined simultaneously with the consumption decision. The extended model could also be used to test whether preferences for the allocation of potential expenditure over goods and leisure depends on household composition. This may enhance our understanding of the differences between the labor supply of singles and members of couples. Chapter 4 also considers this issue.

Appendix

2.A Theory

2.A.1 The individual model

As discussed above there are several factors that may explain the difference in expenditure patterns of single person households and (childless) couple households. In general we have an identification problem: There is a continuum of explanations for the difference between singles and couples expenditure which vary in terms of intra-household distribution, the strength of economies of scale and household composition dependent preferences. Expenditure differences may be studied in a collective model by imposing more structure on the general collective model. We thereby rule out one or more of the possible explanations for different expenditure patterns. Several possibilities can be thought of. Assumptions about the public or private nature of goods can help to identify preference changes (see Browning, Chiappori, and Lewbel 2013, section 6.3 for a discussion). Alternatively, restricting preferences can help to identify economies of scale in the consumption of goods and the division of consumption expenditure between partners. In this section we consider a special case of the cooperative collective model where goods are either assignable and purely privately consumed or publicly consumed and subject to economies of scale.[30]

To create a model that allows preferences to depend on household composition we make the (aforementioned) distinction between goods that are assignable to an individual and goods that are not assignable to an individual.[31] In the single person household, the sole member of the household seeks

[30]The model can be extended to include the demand for leisure/supply of labor. This is outside the scope of the current paper. We consider this extension an interesting avenue for future research.

[31]In an earlier version of the paper we also assumed additive separability in the subset

to maximize the individual utility function

$$U^k = U^k(\boldsymbol{q}^{k,A}, \boldsymbol{q}^{k,N}, \boldsymbol{z}^k), \tag{2.18}$$

where $\boldsymbol{q}^{k,A}$ and $\boldsymbol{q}^{k,N}$ in equation (2.18) are vectors of assignable and non-assignable good quantities respectively and $\boldsymbol{z}^k$ is a vector of background variables assumed to affect preferences. The corresponding indirect utility function is

$$V^k = V^k(\boldsymbol{p}^A, \boldsymbol{p}^N, x^k, \boldsymbol{z}^k), \tag{2.19}$$

where $\boldsymbol{p}^A$ and $\boldsymbol{p}^N$ in equation (2.19) are vectors of market prices for respectively assignable and non-assignable good and x^k is (individual) total expenditure. We have explicitly recognized everywhere that the utility function depends on an individual's background variables $\boldsymbol{z}^k$. Perhaps the most important background variable is the gender of the individual. The superscript $k = sf, sm$ is used above to distinguish between functions, variables and parameters for single women and single men. In the (couple) household model below we use $k = cf, cm$ to refer to functions, variables and parameters for the female and male member of the couple.

2.A.2 The household model

As in Chiappori (1988) the allocation of resources within the household is assumed to be Pareto efficient. The household can therefore be seen to maximize a weighted sum of individual utilities. The household problem may be represented as

$$\begin{aligned}
\max_{\boldsymbol{q}^{cf,A}, \boldsymbol{q}^{cf,N}, \boldsymbol{q}^{cm,A}, \boldsymbol{q}^{cm,N}} U^h &= U^{cf}(\boldsymbol{q}^{cf,A}, \boldsymbol{q}^{cf,N}) + \mu U^{cm}(\boldsymbol{q}^{cm,A}, \boldsymbol{q}^{cm,N}) \\
\text{s.t. } x &= \boldsymbol{p}^{A\prime}\boldsymbol{y}^A + \boldsymbol{p}^{N\prime}\boldsymbol{y}^N \\
\boldsymbol{y}^N &= \boldsymbol{F}(\boldsymbol{q}^{cf,N}, \boldsymbol{q}^{cm,N}) \\
\boldsymbol{y}^A &= \boldsymbol{q}^{cf,A} + \boldsymbol{q}^{cm,A},
\end{aligned}$$

of assignable and non-assignable goods. The benefit of this assumption was that we could break up estimation of the model in terms of two simple systems. A system of assignable goods budget shares was used to estimate household composition dependent preferences, while a system of non-assignable goods budget shares was used to estimate sharing and economies of scale parameters. A test of the separability hypothesis was (weakly and non-robustly) rejected. The underlying reason that separability fails to hold seems to be that there exists significant complementarity between expenditure on eating out and leisure activities and expenditure on transportation.

where $\boldsymbol{q}^{cf,A}$, $\boldsymbol{q}^{cf,N}$, $\boldsymbol{q}^{cm,A}$ and $\boldsymbol{q}^{cm,N}$ are consumed quantities of goods (the "consumed" part is explained below), $\boldsymbol{y}^A$ and $\boldsymbol{y}^N$ are purchased quantities of goods at the household level, x is total household expenditure and μ is the weight that the husband's utility has in the household utility function. We can interpret this as the wife's problem of allocating expenditure to her own and her husband's consumption subject to the constraint that the husband gets some previously agreed upon level of utility and subject to the budget constraint. As is a common approach in the literature, the exact process that determines the utility weight μ is left unspecified. Instead we estimate a relationship between the wife's share in total expenditure and several distribution relevant variables.

We introduce $\boldsymbol{y}^N = \boldsymbol{F}(\boldsymbol{q}^{cf,N}, \boldsymbol{q}^{cm,N})$, an inverse consumption technology function which captures the relationship between purchased and consumed quantities of goods. The distinction between purchased and consumed quantities of goods reflects the efficiency gains from sharing consumption goods in a couple. We follow Browning, Chiappori, and Lewbel (2013) by modeling efficiency gains in consumption as economies of scale in a household production process. Households transform purchased goods into consumable goods. The process whereby consumable goods are produced is subject to economies of scale. We assume that singles consume purchased goods, but couples transform purchased goods into larger consumable quantities of the same goods.[32] For a given quantity of purchases by a member of a couple the corresponding consumable quantity tells us how much the member of that couple would need to purchase as a single to enjoy the same consumption. In this sense we can interpret $\boldsymbol{q}^{k,N}$ as the vector of singles equivalent consumption corresponding to purchases $\boldsymbol{y}^{k,N}$ for $k = cf, cm$. The latter implies that for singles households we have $\boldsymbol{y}^{k,N} = \boldsymbol{q}^{k,N}$ for $k = sf, sm$. Also note that $\boldsymbol{y}^{k,A} = \boldsymbol{q}^{k,A}$ for $k = sf, sm, cf, cm$ since we assume assignable goods are purely private. The consumption technology captures these ideas by specifying a relationship between purchased goods and consumable goods for couples. We use a simple linear technology given by $y_g^{k,N} = d_g q_g^{k,N}$ for

[32] Food consumption provides a clear example in this case. Food waste is smaller in larger households. Larger households waste less because it is easier to buy (and prepare) exactly the right amount of food if that right amount is larger. This is especially the case if ingredients are available only in packages of given weights or sizes. On the one hand, for any purchased quantity of goods more is consumed by the members in a larger household. On the other hand, to eat the same meals the members of the household would need to purchase more food if they were single than they do as part of the household.

$k = cf, cm$ and $g = G_A + 1, \ldots, G$. This is an application of the Barten (1964) model of demographic demand scaling, where the demographic factor is a couple dummy. The d_g parameters can thus be interpreted as Barten scales. The parameters are assumed to lie between 0.5 (perfect public good) and 1 (perfect private good). These values reflect the natural upper and lower bound to sharing in the consumption of purchased goods. For reasons explained below, we assume in the empirical application that all d_g take the same value d. The parameter d can be interpreted as an Engel scale for non-assignable goods.

Corresponding to singles equivalent consumable quantities of goods we can find Lindahl prices. Lindahl prices are nominal prices adjusted for economies of scale in consumption. They are the effective prices paid by members of couples for a singles equivalent unit of consumption. In terms of our model and technology function Lindahl prices are given by $\pi_g = d_g p_g^N$. The Barten scales are used to discount market prices. All members of couples face this same set of effective prices.

The household problem may alternatively be represented as a two stage allocation process. In the first stage household expenditure is divided between the two members according

$$\max_{x^{cf}, x^{cm}} V^h = V^{cf}(x^{cf}, \boldsymbol{p}^A, \boldsymbol{p}^N) + \mu V^{cm}(x^{cm}, \boldsymbol{p}^A, \boldsymbol{p}^N) \qquad (2.20)$$
$$\text{s.t. } x = x^{cf} + x^{cm}.$$

The functions V^{cf} and V^{cm} in program (2.20) are found by substituting the solution of the second stage program (2.21) back into the direct utility functions U^{cf} and U^{cm}. In the second stage a member of a couple solves the program (2.21)

$$\max_{\boldsymbol{q}^{k,A}, \boldsymbol{q}^{k,N}} U^k(\boldsymbol{q}^{k,A}, \boldsymbol{q}^{k,N}, \boldsymbol{z}^k) \qquad \text{s.t. } x^k = \eta^k x = \boldsymbol{p}^{A\prime} \boldsymbol{q}^{k,A} + \boldsymbol{\pi}^{N\prime} \boldsymbol{q}^{k,N}, \qquad (2.21)$$

for $g = G_A + 1, \ldots, G$ and $k = cf, cm$.

The couple member's problem is similar to the single's problem of maximizing equation (2.18). A couple member finds the best allocation they can reach with their share (η^k) of household expenditure (x). In contrast to singles they evaluate the marginal unit cost of consuming goods at Lindahl prices ($\boldsymbol{\pi}^N, \boldsymbol{p}^A$) as opposed to market prices ($\boldsymbol{p}^N, \boldsymbol{p}^A$). The Lindahl prices implied by the linear consumption technology are independent of quantities and thus of the spouse's allocation as proven in Browning, Chiappori, and Lewbel (2013).

The modeling approach essentially makes the most of the rich individual consumption data. By analyzing three assignable goods budget shares for either household type we can reveal preferences and their dependence on household type. Individual consumption data allows us to identify all couple member's preferences parameters specific to assignable goods budget shares. Furthermore, we can avoid assumptions that have been rejected by previous research (e.g. the independence of base assumption of Bargain and Donni (2012)). For the remaining parameters we face the same identification problem as earlier studies. Expenditure on (partially) public goods is per definition not assignable to individual couple members.[33] For individuals living alone household consumption is equal to individual consumption. We can therefore reveal consumption preferences of singles by studying singles' budget allocations. We follow Browning, Chiappori, and Lewbel (2013) and assume that individuals in couple households have the same preferences over non-assignable goods as otherwise similar (in terms of gender and taste shifters) individuals who live alone. In terms of the model discussed above some of the structural elements of $U^{cf}(U^{cm})$ are set equal to the corresponding elements in $U^{sf}(U^{sm})$. We use this assumption to identify the share of expenditure ($\eta^k x$) available to and effective price of non-assignable's consumption (d) faced by couple members from household level consumption data.[34] However, without assignable expenditure data we would have to constrain all structural preference elements of $U^{cf}(U^{cm})$ to achieve the same result. In Section 2.3 we specify a parametric model that allows straightforward testing of the hypothesis that preferences of singles and otherwise similar members of couples are the same.

[33]The use and benefit to individuals may sometimes be inferred from complementary data. For example, while a car can be considered a household public good it may be possible to infer the benefit the car has to each member if each member's use of the car was recorded.

[34]The expenditure share and effective price are also arguments of the assignable goods budget shares. They determine the effective expenditure a couple member can allocate. Identification of preference parameters in assignable goods budget shares thus depends on identification of the effective price and expenditure share from non-assignable goods data. This complication is discussed in the context of the parametric model introduced in Section 2.3.

2.B Derivations

2.B.1 Household demand and budget shares

We can find the individual demand functions for men and women in single person and couple household by normal methods. We apply Roy's identity to the indirect utility function in equation (2.19) to find the individual demand functions

$$q_g^k = h_g^k\left(\frac{\boldsymbol{p}}{x^k}\right) \qquad \text{for } k = sf, sm, cf, cm$$

where x^k is individual total expenditure, $\boldsymbol{p}$ is the G by 1 vector of prices, and $k = sf, sm, cf, cm$ are shorthand for single women, single men, women in couples and men in couples.

We assume that couples come to a Pareto efficient distribution of total expenditure. The wife's share is denoted by $\eta^{cf} = \eta$ and the husband share is denoted by $\eta^{cm} = 1 - \eta$. We also assume there are economies of scale in the consumption of non-assignable goods by couples. We represent this assumption by the consumption technology

$$y_g^h = d_g(q_g^{cf} + q_g^{cm}),$$

where $d_g = 1$ for $g = 1, \ldots, G_A$.

Individual consumption demand by couple members is evaluated at the effective price for consumption $\pi_g = d_g p_g$ using the budget available to the individual $x^k = \eta^k x$. This gives us

$$q_g^k = h_g^k\left(\frac{\boldsymbol{\pi}}{\eta^k x}\right) \qquad \text{for } k = cf, cm.$$

Household demand is found by substituting the individual demand functions for the wife and husband into the consumption technology

$$y_g^h = d_g h_g^{cf}\left(\frac{\boldsymbol{\pi}}{\eta^{cf} x}\right) + d_g h_g^{cm}\left(\frac{\boldsymbol{\pi}}{\eta^{cm} x}\right).$$

Household expenditure shares are given by equation (2.22)

$$w_g^h = \frac{p_g y_g^h}{x} = \eta^{cf} w_g^{cf}\left(\frac{\boldsymbol{\pi}}{\eta^{cf} x}\right) + \eta^{cm} w_g^{cm}\left(\frac{\boldsymbol{\pi}}{\eta^{cm} x}\right), \tag{2.22}$$

where w_g^{cf} and w_g^{cm} are budget shares w.r.t. the individual budget given by

$$w_g^k = h_g^k \left(\frac{\boldsymbol{\pi}}{\eta^k x} \right) \frac{\pi_g}{\eta^k x}.$$

2.B.2 Demand in the parameterized model

We have the indirect utility function

$$V^k(x^k, \boldsymbol{p}, \boldsymbol{z}^k) = \frac{\ln x^k - \ln a^k(\boldsymbol{p}, \boldsymbol{z}^k)}{b^k(\boldsymbol{p})}$$

where $k = sf, sm, cf, cm$ and

$$\begin{aligned}
\ln a^k(\boldsymbol{p}) &= \alpha_0 + \sum_{i=1}^{G_A} \alpha_i^k(\boldsymbol{z}^k) \ln p_i + \sum_{i=G_A+1}^{G} \alpha_i^k(\boldsymbol{z}^k) \ln p_i, \\
b^k(\boldsymbol{p}) &= \prod_{i=1}^{G_A} p_i^{\beta_i^k(\boldsymbol{z}^k)} \prod_{i=G_A+1}^{G} p_i^{\beta_i^k(\boldsymbol{z}^k)} \\
\alpha_g^k(\boldsymbol{z}^k) &= \alpha_{g,c}^k + \alpha_{g,z}^{k\prime} \boldsymbol{z}^k \\
\beta_g^k(\boldsymbol{z}^k) &= \beta_{g,c}^k + \beta_{g,z}^{k\prime} \boldsymbol{z}^k.
\end{aligned}$$

Applying Roy's identity to the indirect utility function and multiplying demand functions by $\frac{p_g}{x^k}$ we get expenditure on a good as a share of total expenditure on private goods. These budget shares are given by

$$w_g^k = \frac{p_g q_g}{x^k} = \alpha_g^k(\boldsymbol{z}^k) + \beta_g^k(\boldsymbol{z}^k)(\ln(x^k) - \alpha_0 - \sum_{i=1}^{G} \alpha_i^k(\boldsymbol{z}^k) \ln(p_i)) \qquad (2.23)$$

or

$$w_g^k = \alpha_g^k(\boldsymbol{z}^k) - \alpha_0 \beta_g^k(\boldsymbol{z}^k) - \beta_g^k(\boldsymbol{z}^k) \sum_{i=1}^{G} \alpha_i^k(\boldsymbol{z}^k) \ln \frac{p_i}{x^k}.$$

where we have made use of the fact that $\sum_i^G \alpha_i^k(\boldsymbol{z}^k) = \mathbf{1}$. Couple members evaluate equation (2.23) at effective prices and their share of household expenditure

$$w_g^k = \frac{\pi_g q_g}{\eta^k x} = \alpha_g^k(\boldsymbol{z}^k) + \beta_g^k(\boldsymbol{z}^k)(\ln(\eta^k x) - \alpha_0 - \sum_{i=1}^{G} \alpha_i^k(\boldsymbol{z}^k) \ln(\pi_i)). \qquad (2.24)$$

We normalize all prices to 1 in equation (2.23) and equation (2.24). The budget shares for singles therefore simplify to

$$w_g^k = \alpha_g^k(\boldsymbol{z}^k) + \beta_g^k(\boldsymbol{z}^k)(\ln(x^k) - \alpha_0). \tag{2.25}$$

Equation (2.25) can be rewritten in reduced form to get equation (2.4) in the main text. The individual budget shares for couple members simplify to

$$w_g^k = \frac{\pi_g q_g}{\eta^k x} = \alpha_g^k(\boldsymbol{z}^k) + \beta_g^k(\boldsymbol{z}^k)(\ln(\eta^k x) - \alpha_0 - \sum_{i=1}^{G} \alpha_i^k(\boldsymbol{z}^k)\ln(d_i)). \tag{2.26}$$

If we impose that economies of scale are equally strong in each good ($d_g = d$) then equation (2.26) simplifies to equation (2.8) in the main text. The budget shares in equation (2.26) are unobservable since individual total expenditure $\eta^k x$ depends in part on an individual's share of non-assignable goods expenditure. In order to derive observable household level budget shares for couple member's individual expenditure we multiply equation (2.26) by η^k

$$w_g^k = \frac{\pi_g q_g^k}{x} = \eta^k \left[\alpha_g^k(\boldsymbol{z}^k) + \beta_g^k(\boldsymbol{z}^k)(\ln(\eta^k x) - \alpha_0 - \sum_{i=1}^{G} \alpha_i^k(\boldsymbol{z}^k)\ln(d_i))\right]. \tag{2.27}$$

Equation (2.27) simplified using $d_g = d$ gives the household level budget shares of assignable goods for the wife and the husband used in equation (2.5) and (2.6) in the main text. The sum of the household level budget shares of non-assignable goods for the wife and husband gives equation (2.7).

2.C Endogeneity

In this section we report the results of tests of exogeneity and instrument relevance. The null hypothesis for instrument relevance is that in a regression of total expenditure (or its interaction with a taste shifter) the coefficients on the excluded instruments (log income and its interactions with taste shifters) are jointly equal to zero. We estimate the system of 4 equations by applying OLS equation by equation[35]. The Wald test statistics of the joint test that

[35] One equation has total expenditure as the dependent variable, the other three have an interaction of total expenditure with respectively age, homeownership and education as the dependent variable. The covariance matrix is adjusted to account for clustering

the coefficient of each of the 4 excluded instrument is zero in each regression is 154.51 for single women and 97.58 for single men. In either case the set of instruments is jointly significant.

To address endogeneity we added the residuals from the regressions described above to the singles demand system in equation (2.4). The null hypothesis of the test for exogeneity is that the coefficients on the first stage residuals are jointly zero (in each budget share separately). The results are presented in Table 2.9. We find evidence against the hypothesis that (log) total expenditure is exogenous in the budget shares for utilities (only for women), transport and insurance (only for men). Hence we proceed to use the instruments.

Table 2.9: Tests of exogeneity

	Single women		Single men	
Budget share	χ^2	P-value	χ^2	P-value
Housing	2.79	0.5927	4.52	0.3400
Utilities	25.64	0.0000	6.53	0.1630
Transport	21.93	0.0002	12.50	0.0140
Food at home	3.79	0.4353	5.73	0.2199
Insurance	1.45	0.8348	15.54	0.0037
Leisure	3.53	0.4739	14.93	0.0048
Clothing	7.09	0.1310	7.16	0.1278
Personal care	3.17	0.5299	1.93	0.7479

and correlation between errors of the 4 equations.

Chapter 3

Daycare Cost and Time Use.[1]

3.1 Introduction

This paper studies the relation between daycare use and labor supply of parents with young children. Specifically, we analyze the effects of a 2011-2013 reform which reduced the generosity of the daycare subsidy in the Netherlands. Aside from the effect on daycare use, we are interested in the effects on the parents' consumption of private goods, consumption of public goods, labor supply and other time uses. We also consider the possibility that increased daycare cost change the participation decision of the mother and the parents decision to use daycare. We therefore introduce a model that allows for non-participation of the mother in the labor market and for the possibility that households choose not to use daycare.

Rules regarding daycare provision in the Netherlands have undergone a series of changes since 2005. The resulting variation in daycare cost provides a good opportunity to study the relation between daycare cost and labor supply. January 2005 saw the introduction of a new law on the provision of a child care subsidy ("Besluit kinderopvangtoeslag"). The 2005 law replaced a system where subsidies were paid to daycare providers with a system that paid subsidies to households. Subsidies were also extended to small scale child care by so-called guestparents, leveling the playing field between guestparent care and formal child care in larger scale centers. Subsidies are paid only to one earner, single parent households and dual earner, two parent households.

[1] I would like to thanks participants and discussants at the SEHO 2018 conference and SOM PhD conference for useful comments and discussion. Special thanks to my supervisors Rob Alessie and Jochem de Bresser for their invaluable help and support.

The subsidy rate declines stepwise with household income. Furthermore, a higher subsidy rate applies to the daycare cost for every child after the first. The subsidy was made considerably more generous in 2006 and 2007. One of the stated goals of the new law was to promote the combination of work and care by the parents. While not explicitly stated as a goal, the expected effect of the new law was an increase in labor force participation by parents especially mothers. Bettendorf, Jongen, and Muller (2015) report that the parent's share of daycare cost halved from 37% to 18% on average between 2005 and 2007. Using a difference in difference approach they find that the reforms in the 2005-2009 period had only a modest effect on the employment rate (+2.3 percentage point) and hours worked (+1.1 hour per week) of mothers with young children, despite a tripling of the outlays over the same period. To control the cost of the subsidy program the system was reformed between 2011 and 2013. Our empirical analysis focuses on the 2011-2013 reform. The details of the reform are discussed further below. The goal was to reduce the average subsidized share of daycare cost from 78% in 2010 to 66% in 2015 (Netherlands Court of Audit (2014)). The reform was successful in this regard. The Ministry of Social Affairs and Employment (2016) reports that the average subsidy had declined to 62% in 2015.

The approach in this paper differs from Bettendorf, Jongen, and Muller (2015) in that we simulate policy responses based on a structural model of daycare use and labor supply. The advantage is that we can separate the effects of the subsidy cut from concurrent policy changes and macro-economic effects. To evaluate the effects of the daycare reform we work with a modified version of the collective household production model of Cherchye, de Rock, and Vermeulen (2012b). As in Cherchye, de Rock, and Vermeulen (2012b) the husband is assumed to participate in the labor market, although he is free to choose the number of hours worked per week. The model is modified so as to allow corner responses with respect to maternal labor supply and use of daycare. We estimate the model based on data from before (2009, 2010) and during the reform (2012). Subsequently, we use the estimated model to predict outcomes during (2012) and after the reform (2015). For 2012 and 2015, we also predict outcomes under the counterfactual that the pre-reform system is still in place. Based on a comparison of these outcomes we predict the effects of the reform.

From a technical point of view this paper's distinguishing feature is that it derives wages for mothers who do not work and a price of daycare for non-utilizing households from rationing conditions. Mothers are limited to working non-negative hours. Implicitly this leads to rationing of other uses of mothers' times. Fathers are assumed to always work positive hours to reduce the model's complexity. Households face a lower limit on the number of hours of daycare they use (generally half a day of daycare per child per week). Our approach is consistent with the theory of demand under rationing as presented in Tobin and Houthakker (1950) and Neary and Roberts (1980). Following Neary and Roberts (1980) whenever a household experiences rationing of (maternal) labor supply or daycare hours we evaluate all demand/supply functions at so-called shadow prices (or wages in the case of labor supply). The shadow wage is the wage at which the wife voluntarily chooses to work zero hours (hence a reservation wage). Similarly the shadow price of daycare is the price at which the household voluntarily chooses minimum daycare hours. Shadow wages and prices are unobservable and explicit closed form solutions do not exist for the parametric model used in this paper. We therefore use a numerical approach similar in spirit to Kooreman and Kapteyn (1986) to calculate the mother's shadow wage and household's child care price.

We predict that in 2012, in response to the reduction of the daycare subsidy, households reduce their gross daycare expenditure by on average €232 per month. This amounts to on average a 42% reduction with respect to the amount they would have spent had the 2010 system still been in place. Similarly, in 2015 households are predict to reduce daycare expenditure by on average 264 per month or 47% of the amount they would have spent had 2010 system still been in place. Despite the large reduction in gross daycare expenditure, and thus daycare hours, we predict only very modest time use responses. Parents are predicted to reduce labor supply by only a few minutes per week. The time redistributed to parental child care is by no means enough to substitute for commercial daycare. The results suggest that households may have informal alternatives to commercial daycare.

In Section 3.3 we discuss the relevant details of the Dutch institutional setting and changes to daycare legislation in the 2009-2015 period. Section 3.4 starts with a short description of the Cherchye, de Rock, and Vermeulen (2012b) model. Thereafter we discuss how maternal non-participation in the labor market and non-participation of the household in daycare are incorporated in the aforementioned model. Section 3.5 discusses the data used to estimate the model and evaluate the effect of the 2011-2013 reform. Section

3.6 presents the estimatation results and simulates the effects of the reform. Finally, Section 3.7 concludes.

3.2 Literature review

Given the marked increase in labor supply by mothers of young children, the relation between daycare cost and maternal employment has deservedly received considerable attention. Blau and Robins (1988) develop a one period discrete choice model of maternal labor supply, informal child care use and formal child care use. They find that formal child care cost affects labor supply and formal child care use negatively. Connelly (1992) and Ribar (1992) come to the same conclusion. Berger and Black (1992) use US data to analyze the effect of a child care subsidy program on maternal labor supply and child care quality. Comparing treated households with households on the program's waiting list they find a significant positive effect of treatment on the probability of employment and a small effect on hours worked. Ribar (1995) uses a structural discrete choice model of labor supply and child care utilization to simulate the effect of alternative child care subsidy proposals. These and various studies that followed it produced a wide range of estimates of the elasticity of employment to child care cost. Blau (2003) surveys the literature and suggests that wide range of estimates may be explained by differences in the approach used to estimate wages and child care cost.

More recent contributions have focused on using exogenous variation in child care cost, induced by quasi-natural experiments, to identify the response of employment to child care cost. For example, Baker, Gruber, and Milligan (2008) analyze the effect of the introduction of a universal subsidized child care system in Quebec on maternal labor supply and child care use. They find an 14.5% increase of employment relative to the baseline and an increase in child care use among young children by a third relative to the baseline. Despite sizable effects on employment, the increase in tax revenues was predicted to be 40% of the cost of the program. Hardoy and Schøne (2015) study the effect of a reform in Norway that reduced child care cost and increased child care coverage. Despite the fact that the maternal employment rate in their control group is high they find a 4 percentage point treatment effect on the employment rate. The Dutch context is similar to that of Norway in that the female employment rate at 72.3% (OECD 2009, population aged 15-64) is relatively high amongst developed economies. However, conditional on working Dutch women work on average 24.3 hours per week (OECD 2009, usual hours worked per week) which is relatively low compared to the OECD average of 33.2 hours per week. Given the high share of part-time work, the intensive margin effects of higher child care cost may be relatively important in the Dutch context. The aforementioned quasi-experimental study by Bettendorf, Jongen, and Muller (2015), which analyzed an increase in the Dutch daycare subsidy between 2005 and 2009, found a positive effect of 2.3 percentage point on the employment rate. Comprehensive surveys of recent additions to the cost of child care and employment literature are given in Kalb (2009) and Del Boca (2015).

Other recent studies such as Kornstad and Thoresen (2007) and Apps, Kabátek, et al. (2016) use unitary structural discrete choice models to simulate the response of maternal time use to changes in (amongst other things) the price of commercial child care. Both find strong time use responses to changes in the child care cost. [2] We also use a structural model to simulate responses to changes in the price of daycare. However, we widen the set of outcomes to parental consumption of private goods, consumption of a public good and time use other than labor or child care. The model also differs substantially. We use a model with continuous time use and expenditure outcomes. Whereas labor supply is usually limited to a discrete number of options, it may be argued that parents have far more freedom to choose how much time they work at home, care for their children or spend on leisure. By using a continuous outcomes model we are introducing realism with respect to the non-labor supply outcomes while sacrificing realism with respect to the choice of labor supply. Another difference with the aforementioned studies is that the structural model is a collective rather than unitary model of household decision making. An advantage of the collective approach is that it allows heterogeneity of response to the subsidy cut with respect to the decision making power (bargaining positions) of fathers and mothers. For example if there are two otherwise similar households one where the father is dictator and one where the mother is a dictator then a collective model can explain why they choose different initial levels of labor supply and day-

[2] Jongen, de Boer, and Dekker (2014) develop a unitary discrete choice model of labor supply and daycare use which they use to simulate (amongst other things) the effects of an increase in the Dutch daycare subsidy on administrative dataset. They consider the effect of a hypothetical 500 million euro increase in the outlays of the subsidy program and predict that mothers in couples increase hours worked by 1.9%, and fathers in couples increase hours worked by 0.2% and hours of formal daycare are increased by 22.9%.

care use and adjust those levels differently in response to a daycare subsidy cut. Finally, the present study focuses on an increase in the cost of daycare while the aforementioned studies were concerned with situations were the cost of daycare increased. A contribution of the present paper is thus to check whether the response to the cost of daycare is symmetrical.

3.3 Institutional setting

Provision and funding of child care has been an area of active reform over the last decade. Here we focus on the institutional setting in 2009 and policy changes that took effect in the years 2011-2013. The majority of child care providers are subsidized by the central government. Subsidized child care centers come in three types. Daycare centers ("dagopvang") provide full day care to children aged 0 to 4. Children of elementary school age (5-12) can be brought to out-of-school care centers ("buitenschoolse opvang"). As the name implies these centers provide child care before, between (Dutch schools traditionally take a break between the morning and afternoon) or after school hours. Since 2005 so-called guest parent care also qualifies for a government subsidy. Guest parent care is organized at a smaller scale than child care in centers. For the purpose of the analysis we treat these types of daycare as a single good. We do allow the demand for daycare to vary with the number of children in the 0 to 4 and 5 to 12 age group in order to capture some of the relevant differences between the types of daycare. Daycare subsidies are paid directly to parents or at the parents request to the daycare provider. Subsidy rates are specified relative to a maximum hourly price of daycare, which was set at €6.10 in 2009. The maximum hourly price is indexed by a weighted average of market wages and a consumer price index. Contrary to what the name implies, the maximum hourly price is not an explicit restriction on the market price of daycare, but rather a maximum price up to which the government is willing to subsidize daycare. If the daycare price is higher than the maximum hourly price then the household pays the entire difference. As a result daycare providers tend to charge a price equal to or just below the maximum hourly price. In 2009 the subsidy rate could be as high as 95.5% for the first child and 96.5% for each other child. The subsidy rates decline stepwise as a household moves to higher income brackets. Income brackets are indexed by a weighted average of the growth in market wages and a consumer price index. The subsidy rate levels off at 33.3% for the first child and 84% for each other child in 2009. Subsidies are only available to dual earner households and working single parents. For children age 0 to 4 an alternative to subsidized care exists in the form of children's play groups ("peuterspeelzaal"). Qualitatively similar to the subsidized sector, these play groups offer child care for two to four half days per week. Play groups are partially funded by municipalities and partially by means of a parental contribution. As such they are a relatively inexpensive option for single earner household and single stay at home parents. Starting in 2018 the child care subsidy also applies to children play groups (as these will be converted to daycare centers). From this point we will use the word daycare as a synonym for all forms of subsidized commercial child care, even though daycare in Dutch refers to a specific type of child care for children aged 0 to 4 ("dagopvang").

During the 2009-2013 period concerns about the rising cost of daycare led to changes to the rules regarding the daycare subsidy. In 2011 the subsidy rate was reduced for all households earning less than €114,813 annually.[3] Second, in 2012 the subsidy rates were reduced further in the same manner as in 2011. The combined effect is visible in Figure 3.1 which plots the first and second child subsidy rate in 2010, 2012 and 2015. Furthermore, starting in 2012 the maximum number of subsidized hours was tied to hours worked by the parent working fewest hours. The maximum number of hours was set equal to the hours worked by the parent working fewest hours multiplied by 0.7 for children of school-going age and multiplied by 1.4 for younger children.[4] Finally, in 2013 the subsidy rates for the first child were reduced at all income levels.[5] The second child subsidy rate was left unchanged after 2012. We observe households in the pre- reform period (2009 and 2010) after the 2011 and 2012 reform have been implemented (2012) and after the

[3]In 2010 households earning more than €114,813 received the minimum subsidy rate of 33.3% for the first child. In 2011-2012 households earning more than €91,652 received the minimum subsidy rate. For the second child (and all other children thereafter) the subsidy rate was affected in a similar manner.

[4]A prior reform in 2010 had limited the number of hours per month to 230 per child. Note that this maximum is unlikely to be very effective: 230 hours per month works out to almost 12 hours per workday assuming a 5 day workweek and 25 vacation days a year. We therefore ignore the changes in 2010 in our analysis.

[5]The minimum subsidy rate of 33.3% for the first child was lowered to 0% in 2013. This proved to be a temporary measure as a new minimum subsidy rate of 18% was introduced in 2014. This minimum subsidy rate applied to household earning more than €103,574. No further changes took place in 2015.

2013 reform has been implemented (2015). The Ministry of Social Affairs and Employment (2012, 2013, 2014) reports that the average parental share of daycare cost (one minus the subsidy rate) increased from 22% in 2010 to 27% in 2011, 33% in 2012 and 40% in 2013, see Figure 3.2(a). Figure 3.2(b) also presents total government spending on the daycare subsidy as reported in Ministry of Social Affairs and Employment (2012, 2013, 2014, 2015, 2016, 2017b) and yearly hours of daycare use per child as reported in Bracheorganisatie Kinderopvang (2016). We observe that total daycare use rises dramatically between 2005 and 2010. The turning point comes after the first round of subsidy cuts in 2011. Total expenditure on the daycare subsidy decrease by about a third between 2010 and 2013. A similar pattern is visible for the number of hours of daycare used per child for each of the forms of subsidized child care. The Ministry of Social Affairs and Employment reports that between 2010 and 2013 the number of household using subsidized daycare decreases from about 475 thousand to 425 thousand. In terms of daycare use, the reform seems to have had strong effects along both the intensive and extensive margin. This the key fact that we try to match with our model.

3.4 The model

3.4.1 A model without rationing

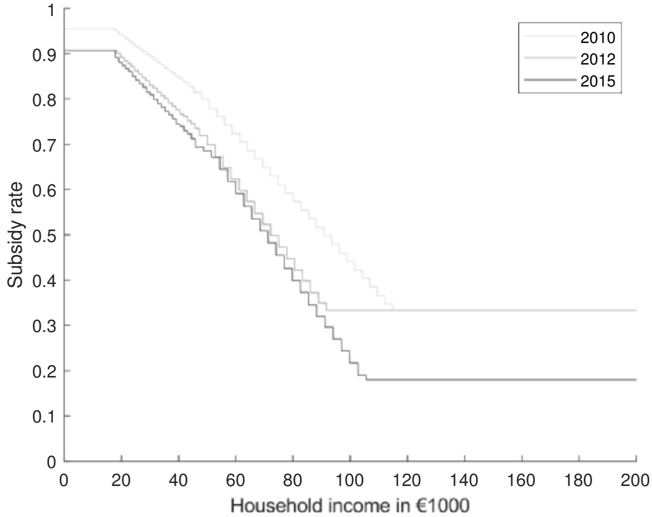
The model used below is based on the collective model with household production of Cherchye, de Rock, and Vermeulen (2012b). We indicate departures from Cherchye, de Rock, and Vermeulen (2012b) where necessary. In order to study the effects of a change in child care subsidies we modify the household production function for child utility. In Cherchye, de Rock, and Vermeulen (2012b) individual utility is given by

$$u_i = u_i(c_i, l_i, u^k(c^k, h_1^k, h_2^k; \boldsymbol{s^k}), u^p(c^p, h_1^p, h_2^p; \boldsymbol{s^p})). \tag{3.1}$$

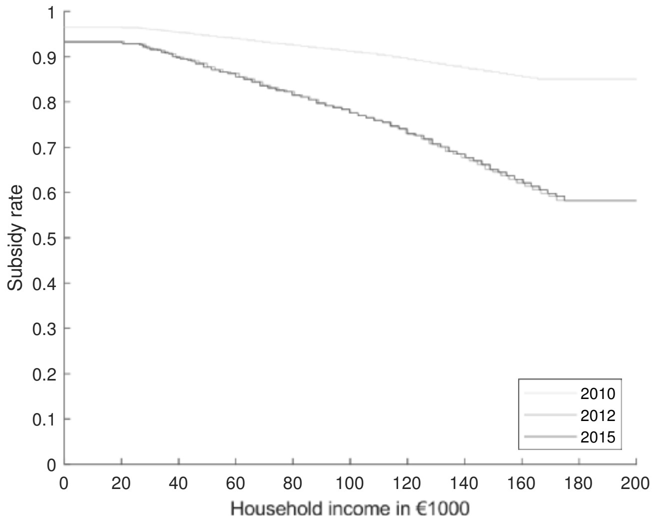
where $i = 1, 2$ indicates the parents in a household, c_i is a parent's consumption of assignable goods and l_i is a parent's leisure time. Parents are assumed to derive utility from their child's utility (u^k). In other words, parents care about their child's happiness. Our interpretation of u^k is that it reflects the parents' perception of their child's utility which may or may not coincide with

Figure 3.1: Subsidy rates in 2010, 2012 and 2015

(a) First child subsidy



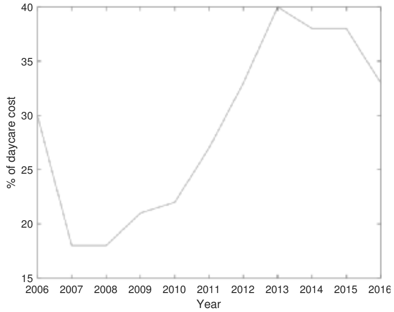
(b) Subsequent children subsidy



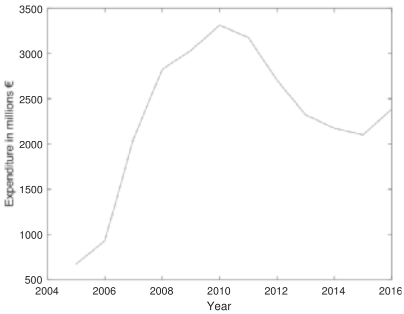
Source: Ministry of Social Affairs and Employment (2017a)

Figure 3.2: Aggregate figures on child care

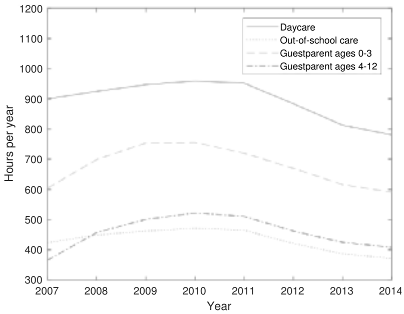
(a) Average parental share in daycare cost



(b) Total daycare subsidies



(c) Yearly hours of daycare per child



Source: Ministry of Social Affairs and Employment (2012, 2013, 2014, 2015, 2016, 2017b), Bracheorganisatie Kinderopvang (2016).

the child's own perception. Child utility is "produced" using expenditure on children (c^k) and either parent's time expenditure on child care tasks (h_k^i) as inputs. Parent's utility also depends on the level of a domestically produced public good (u^p). The public good is produced using expenditure on non-assignable goods (c^p) and either parent's time expenditure on domestic work (h_p^i) as inputs. As in Cherchye, de Rock, and Vermeulen (2012b) we require production shifters to identify the model. Production shifters (given by $\boldsymbol{s^k}$ and $\boldsymbol{s^p}$) are variables that directly affect the level of production but do not directly affect preferences or intra-household bargaining. As in Cherchye, de Rock, and Vermeulen (2012b) we use the number of children and average age of children as production shifters. We add the child gender ratio as an additional production shifters.

We use a modified utility function of the form

$$u_i = u_i(c_i, l_i, u^k(c^k, c^d, u^{pc}(h_1^k, h_2^k; \boldsymbol{s^{pc}}); \boldsymbol{s^k}), u^p(c^p, h_1^p, h_2^p; \boldsymbol{s^p})), \tag{3.2}$$

where $\boldsymbol{s^{pc}}$ is a vector of production shifters. To give daycare expenditure a more prominent role we have split expenditure on children into daycare expenditure (c^d) and non-daycare child expenditure (c^k). The two child expenditure categories are used as separate inputs in the child utility function. Furthermore, we modify the way that time inputs appear in the child utility function. Instead of two separate time inputs we nest a production function for "parental care" sub-utility u^{pc} in the child utility function. Parental care sub-utility is produced by means of the parent's time expenditure on child care. The motivation to add the parental care sub-utility function is that we want to allow a different level of substitutability to hold between paternal and maternal care, which are presumably close substitutes, and maternal (or paternal) care and commercial daycare, which are presumably imperfect substitutes.

The modified household budget constraint is

$$c_1+c_2+c^k+c^p+p^d c^d+w_1(l_1+h_1^k+h_1^p)+w_2(l_2+h_2^k+h_2^p) = y+w_1+w_2, \tag{3.3}$$

where w_1 is the father's wage, w_2 is the mother's wage, y is non-labor income and p^d is the subsidized price of daycare. Individual time constraints are unmodified and given by

$$m_i + l_i + h_i^k + h_i^p = 1 \quad \text{for } i = 1, 2, \tag{3.4}$$

where m_i indicates parent's time in market work.

As in Chiappori (1988, 1992) households are assumed to reach a Pareto efficient intra-household distribution of resources. As a result we can represent the households problem as

$$\begin{aligned}\max_{c_i,l_i,h_i^k,h_i^p} & \Lambda(w_1, w_2, y, \boldsymbol{z})u_1(c_1, l_1, u^k(c^k, c^d, u^{pc}(h_1^k, h_2^k)), u^p(c^p, h_1^p, h_2^p)) \\ & + (1-\Lambda(w_1, w_2, y, \boldsymbol{z}))u_2(c_2, l_2, u^k(c^k, c^d, u^{pc}(h_1^k, h_2^k)), u^p(c^p, h_1^p, h_2^p)) \quad (3.5)\end{aligned}$$

subject to equation (3.3) and (3.4), where the conditioning production shifters in u_i have been suppressed. Λ is the Pareto weight on the father's utility. As in Cherchye, de Rock, and Vermeulen (2012b) we do not model the process of intra-household bargaining and assume Pareto weights are a function of wages, non-labor income and distribution factors $\boldsymbol{z}$. Distribution factors are variables which affect the Pareto efficient outcome reached by bargaining but not preferences or the production process. We assume that Pareto weights are given by

$$\Lambda(\mathbf{z}) = \frac{\exp(\lambda'\mathbf{z})}{1 + \exp(\lambda'\mathbf{z})}, \quad (3.6)$$

We use a number of distribution factors that have been proposed in the literature including the, usually highly relevant, mother-father wage ratio. Identification of the modified model without rationing is discussed in section 3.4.3.

Parametric specification

To introduce the parametric specification we use the two stage budgetting representation of the model. In the first stage the household members come to a decision about the level of the child good u^k, the level of the domestic good u^p and the division of residual non-labor income ρ_1, ρ_2, where $\rho_1 + \rho_2 = y - c^k - c^p - p^d c^d - w_1(h_1^k + h_1^p) - w_2(h_2^k + h_2^p)$. Note that ρ_1 and ρ_2 need not be positive. It is in practice likely that expenditure on non-assignable goods exceeds non-labor income. ρ_1 and ρ_2 represent an agreement to contribute labor income to the purchase of inputs for domestically produced goods. The first stage allocation may therefore put a lower limit on labor supply. We denote the first stage choice of child utility and the domestic goods as $\bar{u^k}$ and $\bar{u^p}$ respectively. The agreement to produce $\bar{u^k}$, $\bar{u^p}$ and the assumption of cost efficient production determine h_i^k and h_i^p. In the second stage the only decision left to the individual is thus how to divide their remaining time between leisure and the additional market work required to fund private expenditures.

Individual indirect utility is given by

$$v_i = \frac{\ln(w_i + \rho_i) - \ln \alpha_i(w_i; \bar{u^k}, \bar{u^p})}{w_i^{\beta_i}} \qquad \text{for } i = 1, 2, \tag{3.7}$$

where $\ln \alpha_i(w_i; \bar{u^k}, \bar{u^p})$ is of the form

$$\ln \alpha_i(w_i; \bar{u^k}, \bar{u^p}) = \alpha_i^0(\bar{u^k}, \bar{u^p}) + \alpha_i^i(d_i) \ln w_i, \tag{3.8}$$

$\alpha_i^0(\bar{u^k}, \bar{u^p})$ is parameterized as

$$\alpha_i^0(\bar{u^k}, \bar{u^p}) = \alpha_i^0 + \alpha_i^{0,k} \ln \bar{u^k} + \alpha_i^{0,p} \ln \bar{u^p}, \tag{3.9}$$

and $\alpha_i^i(d_i)$ equals

$$\ln \alpha_i^i(d_i) = \alpha_i^{1,0} + \alpha_i^{i,1} d_i, \tag{3.10}$$

and d_i a taste shifter affecting the leisure-consumption trade-off. Applying Roy's identity gives us the conditional demand function for leisure and private consumption. Leisure and private consumption are given by

$$\begin{aligned} l_i &= \left[\alpha_i^i(d_i) + \beta_i \ln\left(\frac{w_i + \rho_i}{\alpha_i(w_i, \bar{u^k}, \bar{u^p})}\right)\right] \frac{w_i + \rho_i}{w_i} \qquad (3.11) \\ c_i &= \left[1 - \alpha_i^i(d_i) - \beta_i \ln\left(\frac{w_i + \rho_i}{\alpha_i(w_i, \bar{u^k}, \bar{u^p})}\right)\right] (w_i + \rho_i). \end{aligned}$$

Our specification differs somewhat from the specification used in Cherchye, de Rock, and Vermeulen (2012b). Instead of equations (3.8)-(3.10), they specify

$$\ln \alpha_i(w_i; \bar{u^k}, \bar{u^p}) = \alpha_i^0 + \alpha_i^i(d_i, \bar{u^k}, \bar{u^p}) \ln w_i, \tag{3.12}$$

where $\alpha_i^0 = 0$ and

$$\alpha_i^i(d_i, \bar{u^k}, \bar{u^p}) = \alpha_i^{1,i}(d_i) + \alpha_i^{i,k} \ln \bar{u^k} + \alpha_i^{i,k} \ln \bar{u^p}, \tag{3.13}$$

which implies demand functions as in equation (3.11) but with α_i and α_i^i following equation (3.12) and (3.13).

The Cherchye, de Rock, and Vermeulen (2012b) specification is problematic for our purposes. To explain demand for child care we require a positive relation between parental welfare and child welfare. In the Cherchye, de Rock, and Vermeulen (2012b) specification $\alpha_i^{i,k}$ and $\alpha_i^{i,p}$ must then be negative when $\ln w_i$ is positive. If $\ln w_i$ is negative then $\alpha_i^{i,k}$ and $\alpha_i^{i,p}$ must be positive. In either case equation (3.11) implies that the relation between leisure and child welfare has the opposite sign to β_i. Moreover the relation between consumption and child welfare has the same sign as β_i. A similar result holds for the domestic good. [6] The relation between leisure or consumption and child welfare or the domestic good thus flips around $w_i = 1$. The predicted treatment effects would be highly sensitive to scaling of all monetary variables if we used this specification. For at least some individuals the predicted treatment effect would change sign due to the fact that the non-labor income at which $w_i = 1$ has changed.[7] To be clear, the problem is not that the treatment effect can depend on w_i but that the treatment effect is forced to switch sign at $w_1 = 1$. In our specification the requirement that child welfare and the domestic good are positively related to parental welfare implies that $\alpha_i^{0,k}$ and $\alpha_i^{0,p}$ must be negative irregardless of w_i.

In the first stage of the household problem, households choose the level of the domestic goods and divide residual non-labor income. Following Cherchye, de Rock, and Vermeulen (2012b) we specify CES production functions for the domestic goods. As a consequence the unit prices of the domestic goods are independent of the level of production. We follow their approach and also specify a CES production function for the parental care sub-utility function. Households choose time inputs and expenditure to satisfy

$$\min_{h_1^k, h_1^p, h_2^k, h_2^p, c^k, c^p, c^d} C = \left(h_1^k + h_1^p\right) w_1 + \left(h_2^k + h_2^p\right) w_2 + c^k + c^p + p^d c^d \tag{3.14a}$$

subject to

$$u^p \leq \left[\gamma_1^p \left(h_1^p\right)^{\epsilon^p(\boldsymbol{s})} + \gamma_2^p \left(h_2^p\right)^{\epsilon^p(\boldsymbol{s})} + \gamma_3^p \left(c^p\right)^{\epsilon^p(\boldsymbol{s})}\right]^{\frac{1}{\epsilon^p(\boldsymbol{s})}} \tag{3.14b}$$

[6]If individuals allocated their budget in the seconds stage over three rather than two goods then the requirement that parental welfare and child welfare are positively related implies no particular relation between any one of the three goods and child welfare.

[7]This is true irrespective of the parameter estimates that result when estimation is performed on two alternatively scaled datasets.

$$u^k \leq \left[\gamma_1^k \left(u^{pc}\right)^{\epsilon^k(\boldsymbol{s})} + \gamma_2^k \left(c^d\right)^{\epsilon^k(\boldsymbol{s})} + \gamma_3^k \left(c^k\right)^{\epsilon^k(\boldsymbol{s})}\right]^{\frac{1}{\epsilon^k(\boldsymbol{s})}} \tag{3.14c}$$

$$u^{pc} \leq \left[\gamma_1^{pc} \left(h_1^{pc}\right)^{\epsilon^{pc}(\boldsymbol{s})} + \gamma_1^{pc} \left(h_2^{pc}\right)^{\epsilon^{pc}(\boldsymbol{s})}\right]^{\frac{1}{\epsilon^{pc}(\boldsymbol{s})}} . \tag{3.14d}$$

Minimum cost per unit of utility is given by

$$G^p(w_1, w_2) = \left[\gamma_1^{p\,\frac{-1}{\epsilon^p(\boldsymbol{s})-1}} (w_1)^{\frac{\epsilon^p(\boldsymbol{s})}{\epsilon^p(\boldsymbol{s})-1}} + \gamma_2^{p\,\frac{-1}{\epsilon^p(\boldsymbol{s})-1}} (w_2)^{\frac{\epsilon^p(\boldsymbol{s})}{\epsilon^p(\boldsymbol{s})-1}} + \gamma_3^{p\,\frac{-1}{\epsilon^p(\boldsymbol{s})-1}}\right]^{\frac{\epsilon^p(\boldsymbol{s})-1}{\epsilon^p(\boldsymbol{s})}}$$

$$G^k(w_1, w_2) = \left[\gamma_1^{k\,\frac{-1}{\epsilon^k(\boldsymbol{s})-1}} \left(G^{pc}(w_1, w_2)\right)^{\frac{\epsilon^k(\boldsymbol{s})}{\epsilon^k(\boldsymbol{s})-1}} + \gamma_2^{k\,\frac{-1}{\epsilon^k(\boldsymbol{s})-1}} \left(p^d\right)^{\frac{\epsilon^k(\boldsymbol{s})}{\epsilon^k(\boldsymbol{s})-1}} + \gamma_3^{k\,\frac{-1}{\epsilon^k(\boldsymbol{s})-1}}\right]^{\frac{\epsilon^k(\boldsymbol{s})-1}{\epsilon^k(\boldsymbol{s})}}$$

$$G^{pc}(w_1, w_2) = \left[\gamma_1^{pc\,\frac{-1}{\epsilon^{pc}(\boldsymbol{s})-1}} (w_1)^{\frac{\epsilon^{pc}(\boldsymbol{s})}{\epsilon^{pc}(\boldsymbol{s})-1}} + \gamma_2^{pc\,\frac{-1}{\epsilon^{pc}(\boldsymbol{s})-1}} (w_2)^{\frac{\epsilon^{pc}(\boldsymbol{s})}{\epsilon^{pc}(\boldsymbol{s})-1}}\right]^{\frac{\epsilon^{pc}(\boldsymbol{s})-1}{\epsilon^{pc}(\boldsymbol{s})}} .$$

Consequently, households solve the problem

$$\begin{aligned} \max_{u^k, u^p, \rho_1, \rho_2} \; & \Lambda(w_1, w_2, y, \boldsymbol{z}) v_1(w_1, \rho_1, u^k, u^p) \\ & + (1 - \Lambda(w_1, w_2, y, \boldsymbol{z})) v_2(w_2, \rho_2, u^k, u^p) \end{aligned} \tag{3.15a}$$

subject to

$$\rho_1 + \rho_2 + G^k(w_1, w_2) u^k + G^p(w_1, w_2) u^p = y. \tag{3.15b}$$

The solution to the household's problem is given by

$$\rho_1 = \frac{w_1 + w_2 + y}{X(w_1, w_2, \Lambda)} \frac{\Lambda}{(w_1)^{\beta_1}} - w_1 \tag{3.16}$$

$$\rho_2 = \frac{w_1 + w_2 + y}{X(w_1, w_2, \Lambda)} \frac{1 - \Lambda}{(w_2)^{\beta_2}} - w_2 \tag{3.17}$$

$$u^k = \frac{w_1 + w_2 + y}{X(w_1, w_2, \Lambda)} \frac{1}{G^k(w_1, w_2, p^d)} \left[-\frac{\Lambda}{(w_1)^{\beta_1}} \alpha_1^{0,k} - \frac{1 - \Lambda}{(w_2)^{\beta_2}} \alpha_2^{0,k} \right] \tag{3.18}$$

$$u^p = \frac{w_1 + w_2 + y}{X(w_1, w_2, \Lambda)} \frac{1}{G^p(w_1, w_2, p^d)} \left[-\frac{\Lambda}{(w_1)^{\beta_1}} \alpha_1^{0,p} - \frac{1 - \Lambda}{(w_2)^{\beta_2}} \alpha_2^{0,p} \right] \tag{3.19}$$

$$X = \frac{\Lambda}{(w_1)^{\beta_1}} \left(1 - (\alpha_1^{0,k} + \alpha_1^{0,p})\right) + \frac{1 - \Lambda}{(w_2)^{\beta_2}} \left(1 - (\alpha_2^{0,k} + \alpha_2^{0,p})\right). \tag{3.20}$$

Furthermore, cost minimization implies

$$u^{pc} = \frac{u^k}{G^k(w_1, w_2)^{\epsilon^k(\boldsymbol{s})-1}} \left(\frac{G^{pc}(w_1, w_2)}{\gamma_1^k} \right)^{\frac{1}{\epsilon^k(\boldsymbol{s})}} \tag{3.21}$$

and

$$\begin{aligned}
h_1^k &= \frac{u^{pc}}{G^{pc}(w_1, w_2)^{\epsilon^{pc}(\boldsymbol{s})-1}} \left(\frac{w_1}{\gamma_1^{pc}} \right)^{\frac{1}{\epsilon^{pc}(\boldsymbol{s})}} \\
h_2^k &= \frac{u^{pc}}{G^{pc}(w_1, w_2)^{\epsilon^{pc}(\boldsymbol{s})-1}} \left(\frac{w_2}{\gamma_2^{pc}} \right)^{\frac{1}{\epsilon^{pc}(\boldsymbol{s})}} \\
c^d &= \frac{u^k}{G^k(w_1, w_2)^{\epsilon^k(\boldsymbol{s})-1}} \left(\frac{p^d}{\gamma_2^k} \right)^{\frac{1}{\epsilon^k(\boldsymbol{s})}} \\
c^k &= \frac{u^k}{G^k(w_1, w_2)^{\epsilon^k(\boldsymbol{s})-1}} \left(\frac{1}{\gamma_3^k} \right)^{\frac{1}{\epsilon^k(\boldsymbol{s})}} \\
h_1^p &= \frac{u^p}{G^p(w_1, w_2)^{\epsilon^p(\boldsymbol{s})-1}} \left(\frac{w_1}{\gamma_1^p} \right)^{\frac{1}{\epsilon^p(\boldsymbol{s})}} \\
h_2^p &= \frac{u^p}{G^p(w_1, w_2)^{\epsilon^p(\boldsymbol{s})-1}} \left(\frac{w_2}{\gamma_2^p} \right)^{\frac{1}{\epsilon^p(\boldsymbol{s})}} \\
c^p &= \frac{u^p}{G^p(w_1, w_2)^{\epsilon^p(\boldsymbol{s})-1}} \left(\frac{1}{\gamma_3^p} \right)^{\frac{1}{\epsilon^p(\boldsymbol{s})}}
\end{aligned} \tag{3.22}$$

Following Cherchye, de Rock, and Vermeulen (2012b) we use an individual's age as the sole taste shifter. We use the same set of production shifters ($\boldsymbol{s}$) in each household production function. As production shifters we use the number of children, the average age of children and a child gender ratio. The number and average age of children are likely to affect input productivities in the child utility function. The same may be true for the public good utility function. Since we do not explicitly allow children to benefit from the domestic good, such a benefit may be picked up by a parameter capturing the effect of the number of children on productivity. Furthermore, parents may well combine domestic work and child care which would affect their productivity. We add the child gender ratio to find out whether the (relative) productivity (and substitutability) of maternal and paternal care depends on gender of their children. As distribution factors we use the wife-husband wage ratio, a higher education dummy for both the husband and wife. Furthermore, we allow non-labor income and the husband-wife age difference to enter the sharing rule. The definition of these variables is discussed in section 3.5.

3.4.2 Rationing

Kooreman and Kapteyn (1986) develop a unitary model of household labor supply which incorporates a Tobit like equation for female labor supply, allowing the model to be estimated based on both one earner and two earner families. We are faced with the essentially the same problem. We want to explain household labor supply of both one earner and two earner households. However, there are two notable differences. We disaggregate total composition (dropping the Hicksian composite good assumption is by itself not new in this context) and add a Tobit-like equation for daycare expenditure. We will start by discussing with the unitary framework analyzed in Kooreman and Kapteyn (1986) and consider what complications arise when we introduce a second type of rationing. Subsequently we will discuss rationing in the collective framework.

Household utility is given by

$$U = U(c, l_1, l_2),$$

where c is expenditure on a Hicksian composite good and l_1 and l_2 are leisure of the husband and wife respectively. The corresponding budget constraint is

$$c + w_1 l_1 + w_2 l_2 = w_1 + w_2 + y,$$

where y is non-labor income and price of the Hicksian good is normalized to 1. The demand for leisure is given by

$$\begin{aligned}
&\text{If } l_2 \leq T_2 \begin{cases} l_1 = l_1(w_1, w_2, y) \\ l_2 = l_2^* \end{cases} \\
&\text{If } l_2 > T_2 \begin{cases} l_1 = l_1(w_1, \underline{w}_2, y) \\ l_2 = T_2 \end{cases} \\
&\quad l_2^* = l_2^*(w_1, w_2, y),
\end{aligned}$$

where T_i is a household member's time endowment, l_2^* is the wife's latent leisure demand function and $\underline{w}_2$ is the shadow wage. As in Neary and Roberts (1980) the shadow wage is defined as the wage at which the wife voluntarily chooses not to work/spent her time entire time endowment on leisure (more accurately non-market time in this case). In other words, the shadow wage is the wife's reservation wage.

Daycare rationing

We modify the situation by disaggregating consumption into daycare expenditure (c^d) and a Hicksian composite good (c). The price of the Hicksian composite good is normalized to one. The utility function is given by

$$U = U(c, c^d, l_1, l_2).$$

The corresponding budget constraint is

$$c + p^d c^d + w_1 l_1 + w_2 l_2 = w_1 + w_2 + y,$$

where p^d is the (subsidized) price of daycare.

Dutch daycare providers generally offer child care for a minimum of one half day per week. We define minimum daycare expenditure $\underline{c}^d$ as the level of gross daycare expenditure consistent with consuming daycare for one half day per week. We allow this value to vary with the number of children in the 0 to 4 and 5 to 12 age group. We then specify a latent demand function for daycare (c^{d*}). If latent daycare demand equals or exceeds minimum daycare expenditure then the household consumes the level of latent daycare demand. Otherwise, the household consumes no daycare. The demand for leisure and daycare is given by

$$\text{If } l_2^* \leq T_2 \text{ and } c^{d*} \geq \underline{c}^d \begin{cases} l_1 = l_1(w_1, w_2, p^d, y) \\ l_2 = l_2^* \\ c^d \ = c^{d*} \\ l_2^* = l_2^*(w_1, w_2, p^d, y) \\ c^{d*} = c^{d*}(w_1, w_2, p^d, y) \end{cases} \tag{3.23}$$

$$\text{If } l_2^* > T_2 \text{ and } c^{d*} \geq \underline{c}^d \begin{cases} l_1 = l_1(w_1, \underline{w}_2, p^d, y) \\ l_2 = T_2 \\ c^d \ = c^{d*} \\ l_2^* = l_2^*(w_1, w_2, p^d, y) \\ c^{d*} = c^{d*}(w_1, \underline{w}_2, p^d, y) \end{cases}$$

$$\text{If } l_2^* \leq T_2 \text{ and } c^{d*} < \underline{c}^d \begin{cases} l_1 = l_1(w_1, w_2, \underline{p}^d, y) \\ l_2 = l_2^* \\ c^d \ = 0 \\ l_2^* = l_2^*(w_1, w_2, \underline{p}^d, y) \\ c^{d*} = c^{d*}(w_1, w_2, p^d, y) \end{cases}$$

$$\text{If } l_2^* > T_2 \text{ and } c^{d*} < \underline{c}^d \begin{cases} l_1 = l_1(w_1, \underline{w}_2, \underline{p}^d, y) \\ l_2 = T_2(w_1, \underline{w}_2, \underline{p}^d, y) \\ c^d \ = 0 \\ l_2^* = l_2^*(w_1, w_2, \underline{p}^d, y) \\ c^{d*} = c^{d*}(w_1, \underline{w}_2, p^d, y) \end{cases}$$

Each household falls in one of four cases. In the order they appear in equation (3.23) these are two earner households using daycare, one earner households using daycare, two earner households not using daycare and one earner households not using daycare. We may say that the first group is not affected by rationing, that the second and third group are affected by one type of rationing and that the fourth group is affected by two types of rationing. The complication arising from daycare rationing is that we need to find a shadow price of daycare for households which do not use daycare.

Daycare rationing in the household production model

Consider the Cherchye, de Rock, and Vermeulen (2012b) style model discussed above. We now introduce rationing of daycare expenditure. The normal daycare demand function is replaced by a latent daycare demand function of the same form. Daycare expenditure equals latent daycare demand (c^{d*}) when latent daycare demand exceeds minimum daycare expenditure ($\underline{c}^d$), otherwise daycare expenditure equals zero. The normal leisure demand function is replaced by a latent leisure demand function of the same form. In contrast to the model above, the Cherchye, de Rock, and Vermeulen (2012b) distinguishes four time uses. We define the residual time endowment as $T_i^r = 1 - h_i^k - h_i^p$. The residual time endowment is the amount of time left over after the individual's time contributions to the domestic and child good have been subtracted. Leisure demand equals latent leisure demand when the latter does not exceed the residual time endowment, otherwise leisure demand equals the time endowment. In the former case labor supply is positive while in the latter case it equals zero.

When the household's allocation problem is viewed as a single-stage budgeting problem, the household's time and expenditure allocation is given by

$$
\begin{aligned}
&\text{If } l_2^* \leq T_2^r(w_1, w_2, p^d, y, \boldsymbol{z}, \boldsymbol{s}) \text{ and } c^{d*} \geq \underline{c}^d \begin{cases} l_1 = l_1(w_1, w_2, p^d, y, \boldsymbol{z}, \boldsymbol{s}) \\ l_2 = l_2^* \\ c^d = c^{d*} \\ l_2^* = l_2^*(w_1, w_2, p^d, y, \boldsymbol{z}, \boldsymbol{s}) \\ c^{d*} = c^{d*}(w_1, w_2, p^d, y, \boldsymbol{z}, \boldsymbol{s}) \end{cases} \\
&\text{If } l_2^* > T_2^r(w_1, w_2, p^d, y, \boldsymbol{z}, \boldsymbol{s}) \text{ and } c^{d*} \geq \underline{c}^d \begin{cases} l_1 = l_1(w_1, \underline{w}_2, p^d, y, \boldsymbol{z}, \boldsymbol{s}) \\ l_2 = T_2^r(w_1, \underline{w}_2, p^d, y, \boldsymbol{z}, \boldsymbol{s}) \\ c^d = c^{d*} \\ l_2^* = l_2^*(w_1, w_2, p^d, y, \boldsymbol{z}, \boldsymbol{s}) \\ c^{d*} = c^{d*}(w_1, \underline{w}_2, p^d, y, \boldsymbol{z}, \boldsymbol{s}) \end{cases} \\
&\text{If } l_2^* \leq T_2^r(w_1, w_2, p^d, y, \boldsymbol{z}, \boldsymbol{s}) \text{ and } c^{d*} < \underline{c}^d \begin{cases} l_1 = l_1(w_1, w_2, \underline{p}^d, y, \boldsymbol{z}, \boldsymbol{s}) \\ l_2 = l_2^* \\ c^d = 0 \\ l_2^* = l_2^*(w_1, w_2, \underline{p}^d, y, \boldsymbol{z}, \boldsymbol{s}) \\ c^{d*} = c^{d*}(w_1, w_2, p^d, y, \boldsymbol{z}, \boldsymbol{s}) \end{cases} \\
&\text{If } l_2^* > T_2^r(w_1, w_2, p^d, y, \boldsymbol{z}, \boldsymbol{s}) \text{ and } c^{d*} < \underline{c}^d \begin{cases} l_1 = l_1(w_1, \underline{w}_2, \underline{p}^d, y, \boldsymbol{z}, \boldsymbol{s}) \\ l_2 = T_2^r(w_1, \underline{w}_2, \underline{p}^d, y, \boldsymbol{z}, \boldsymbol{s}) \\ c^d = 0 \\ l_2^* = l_2^*(w_1, w_2, \underline{p}^d, y, \boldsymbol{z}, \boldsymbol{s}) \\ c^{d*} = c^{d*}(w_1, \underline{w}_2, p^d, y, \boldsymbol{z}, \boldsymbol{s}) \end{cases} \\
&\rho_i = \rho_i(\Lambda, y - c^k - c^p - c^d) \\
&T_i^r = T_i - h_i^k - h_i^p \quad \text{for } i = 1, 2,
\end{aligned}
\tag{3.24}
$$

where the variables h_i^k, h_i^p, c_i, c^k and c^p follow the cases of l_1. We have suppressed dependence of functions on taste shifters d_i.

We now ask whether the rationing component prevents us from viewing the household's problem as a two-stage budgeting process. The answer is relevant because the proof of model identification as presented in Cherchye, de Rock, and Vermeulen (2012b) relies on being able to use the two-stage representation. In the remainder of this subsection we argue that their proof of identification is still valid for the rationed model.

As is clear from equation (3.24), the two forms of rationing interact with each other. The wife's leisure demand depends on the price of daycare while demand for daycare depends on the wife's non-labor income. If either good is rationed than demand for the other good depends on a shadow price.

As is discussed in Section 3.4.1, daycare expenditure is determined in the first stage of the allocation process, whereas labor supply is determined in the second stage. The first stage problem is

$$\begin{aligned}\max_{c^k,c^p,c^d,h_i^k,h_i^p,\rho_i} \quad & \Lambda u_1(\rho_1, T - h_1^k - h_1^p, u^k(c^k, c^d, u^{pc}(h_1^k, h_2^k)), u^p(c^p, h_1^p, h_2^p)) \\ & + (1{-}\Lambda) u_2(\rho_2, T - h_2^k - h_2^p, u^k(c^k, c^d, u^{pc}(h_1^k, h_2^k)), u^p(c^p, h_1^p, h_2^p))\end{aligned}$$

subject to

$$\begin{aligned} c^k + c^p + p^d c^d + \rho_1 + \rho_2 &= y + w_1 m_1 + w_2 m_2 \\ m_i + l_i + h_i^k + h_i^p &= T \quad \text{for } i = 1, 2, \end{aligned}$$

using the same notation as above. Solutions are of the form

$$\begin{aligned}
&\text{If } l_2^* \le T_2^r \text{ and } c^{d*} \ge \underline{c}^d \begin{cases} c^k &= c^k(w_1, w_2, p^d, y, \boldsymbol{z}, \boldsymbol{s}) \\ c^d &= c^{d*} \\ c^{d*} &= c^{d*}(w_1, w_2, p^d, y, \boldsymbol{z}, \boldsymbol{s}) \end{cases} \\
&\text{If } l_2^* > T_2^r \text{ and } c^{d*} \ge \underline{c}^d \begin{cases} c^k &= c^k(w_1, \underline{w}_2, p^d, y, \boldsymbol{z}, \boldsymbol{s}) \\ c^d &= c^{d*} \\ c^{d*} &= c^{d*}(w_1, \underline{w}_2, p^d, y, \boldsymbol{z}, \boldsymbol{s}) \end{cases} \\
&\text{If } l_2^* \le T_2^r \text{ and } c^{d*} < \underline{c}^d \begin{cases} c^k &= c^k(w_1, w_2, \underline{p}^d, y, \boldsymbol{z}, \boldsymbol{s}) \\ c^d &= 0 \\ c^{d*} &= c^{d*}(w_1, w_2, p^d, y, \boldsymbol{z}, \boldsymbol{s}) \end{cases} \\
&\text{If } l_2^* > T_2^r \text{ and } c^{d*} < \underline{c}^d \begin{cases} c^k &= c^k(w_1, \underline{w}_2, \underline{p}^d, y, \boldsymbol{z}, \boldsymbol{s}) \\ c^d &= 0 \\ c^{d*} &= c^{d*}(w_1, \underline{w}_2, p^d, y, \boldsymbol{z}, \boldsymbol{s}) \end{cases} \\
&\rho_i = \rho_i(\Lambda, y - c^k - c^p - c^d) \\
&T_i^r = T - h_i^k - h_i^p \quad \text{for } i = 1, 2,
\end{aligned}$$

where h_i^k, h_i^p and c^p follow the same cases as c^k.

The second stage problem is then

$$\max_{c_i, l_i} = u_i(c_i, l_i)$$

subject to

$$\begin{aligned} c_i &= \rho_i + w_i m_i \\ m_i + l_i &= T_i^r \quad \text{for } i = 1, 2. \end{aligned}$$

Solutions are of the form

$$\begin{aligned} l_1 &= \begin{cases} l_1(w_1, w_2, \rho_1, T_1^r) & \text{if } l_2^* \le T_2^r \\ l_1(w_1, \underline{w}_2, \rho_1, T_1^r) & \text{if } l_2^* > T_2^r \end{cases} \\ l_2 &= \begin{cases} l_2^* & \text{if } l_2^* \le T_2^r \\ T_2^r & \text{if } l_2^* > T_2^r \end{cases} \\ l_2^* &= \begin{cases} l_2^*(w_1, w_2, \rho_2, T_2^r) & \text{if } c^{d*} \ge \underline{c}^d \\ l_2^*(w_1, w_2, \rho_2, T_2^r) & \text{if } c^{d*} < \underline{c}^d. \end{cases} \\ \rho_i &= \rho_i(\Lambda, y - c^k - c^p - c^d) \\ T_i^r &= T - h_i^k - h_i^p \quad \text{for } i = 1, 2, \end{aligned}$$

where c_i follow the same cases as l_1. We have suppressed the indirect dependence of l_1 and l_2 on sharing rule variables ($\boldsymbol{z}$) and production shifters ($\boldsymbol{s}$) in.

Note that first stage variables such as the daycare price affect consumption and leisure demand in several ways. First, a change in the price of daycare will affect the relative use of inputs for the child good. The relative input use affects consumption and leisure through residual non-labor income (ρ_i) and residual time (T_i^r). Second, a change in the price of daycare changes the optimal value of child utility. The optimal values of consumption and leisure depend on child utility via the α_i term in equation (3.11). An increase in child utility makes either consumption or leisure more attractive depending on the sign of $beta_i$.

Consider how the two forms of rationing interact in the collective household production model. All first stage outcomes, in particular the decision to use daycare, depend on the price of daycare. The price of daycare may depend on decisions made in the second stage of the household problem. In fact in the Dutch context the price of daycare depends on whether both parents are employed and on household income. The wife's decision to work (or equivalently whether her leisure is rationed) therefore affects whether or not the household uses daycare. This labor supply rationing component of the model is not problematic in terms of the logic of a two stage representation of a collective model. All second stage decisions, including the labor supply decision, are conditional on first stage outcomes. All decisions are (by assumption) made by rational individuals with full information. Hence, the price of daycare is a known function of the wife's labor supply which is itself a known function of first stage outcomes (ρ_2, T_2^r).

There should therefore be no problem viewing the decision to use daycare and demand leisure as the outcome of a first stage division of resources between daycare, other goods and individual resources followed by an individual allocation of resources to leisure and private consumption. The solution to the two stage representation is given by the equations above. Alternatively the household decision can be seen as an efficient agreement specifying each parents time allocation and the allocation of total expenditure to public and private uses.

3.4.3 Identification

Cherchye, de Rock, and Vermeulen (2012b) prove (in their online appendix) that their collective model with household production is identified if there is at least one production shifter and the sum of production factors and distribution factors is at least as great as the number of domestically produced goods. The proof makes use of the two stage allocation process and can be summarized as follows. If the level of the unobserved domestic goods u^k and u^p can be kept constant then the identification result of Chiappori (1988) applies to the second stage problem (consumption-leisure allocation): We can identify preferences over the consumption-leisure allocation and the sharing rule (up to a constant) from observations of household level consumption and individual labor supply. Given observations of individual consumption the location the sharing rule constant can also be identified. Note that individual consumption and labor supply is exactly what Cherchye, de Rock, and Vermeulen (2012b) (and therefore we) observe. The problem solved in Cherchye, de Rock, and Vermeulen (2012b) is under which condition the domestic goods may be treated as constant in the second stage. Note that both the consumption-leisure allocation and the level of domestic goods depend on the wages of both partners (and non-labor income). If only wages (and non-labor income) determined the level of domestic goods then it is impossible to keep domestic goods constant in the second stage. The wage variation that is needed to identify the second stage implies variation in the domestic goods. However, if there is at least one production shifter and one distribution factor (or another production shifter) and proposition 1 applies (the Jacobian of the vector of domestic goods with respect to the production shifter and domestic good is invertible) then the production shifter and distribution factor can be used to keep two domestic goods constant. Proposition 1 guarantees that for any combination of wages and non-labor income we can find a combination of levels of the production shifter and distribution factor that keep the domestic goods at a fixed level. The production shifter and distribution factor play the role of 'absorbing' variation in wages and non-labor income, making the notion of holding domestic goods constant (and identifying the second stage conditional upon domestic goods) feasible. Note that by adding the parental care sub-utility function we are effectively adding a third domestically produced good. Does this imply that we need another production shifter to identify the model?[8] The answer is no. Parental care is an intermediary good, used as an input in producing child utility. We do not need to keep parental care constant the same way we hold child utility and the domestic good constant. If wages vary then we also want the level of parental care (and the parental time inputs) to vary. A cost minimizing household would choose to substitute parental care for daycare or other child expenditure and work more if their wages rose.

3.4.4 Estimation

Consider the system made up of the demand functions for l_1, h_1^k, h_1^p, l_2, h_2^k, h_2^p, c_1, c_2, c^k, c^p and c^d given in structural form in equations (3.11) and (3.22). If we substitute in $\rho_1, \rho_2, u^k, u^p, u^{pc}$ and X from equations (3.16) and (3.21) then we obtain the corresponding reduced form system. Ignoring the rationing aspect of the model for a moment, the reduced form system could be estimated by means of non-linear Seemingly Unrelated Regression.

[8]Note that using an additional production shifter does not pose a practical problem. Cherchye, de Rock, and Vermeulen (2012b) already use two production shifters and multiple distribution factors, enough to identify a model with more than two domestically produced goods. We use additional production shifters.

The model with rationing is obtained by plugging the reduced form system as described above into equation (3.24). In other words depending on whether observed daycare expenditure is greater than the minimum supplied amount we evaluate the system at market or shadow prices of daycare. Depending on whether maternal labor supply is strictly positive we evaluate the reduced form system based on on market or shadow wages.

In order to calculate the shadow wage and shadow price of daycare we need to solve the rationing conditions $c^{d*}(\underline{w}_2, \underline{p}^d) = \underline{c}^d$ and $l_2^*(\underline{w}_2, \underline{p}^d) = \underline{l}_2$ for the corresponding shadow price $\underline{p}^d$ and shadow wage $\underline{w}_2$. For the model specified in section 3.4.1, no closed form solutions for the shadow price of daycare or shadow wage can be found. We therefore use numerical methods in the spirit of Kooreman and Kapteyn (1986) to solve the rationing conditions. The process is visualized in Figure 3.3. For each household we minimize $c^{d*} - \underline{c}^d$ if $c^d < \underline{c}^d$, we minimize $l_2^*(\underline{w}_2, \underline{p}^d) - \underline{l}_2$ if $m_2 = 0$. [9] In other words we estimate the prices that would make a household willingly accept the rations $c^d = \underline{c}^{d*}$ and $m_2 = 0$.[10] The criterion functions in these steps are non-linear in the "parameters" $\underline{w}_2$ and $\underline{p}^d$. We need starting values for the unknown $\underline{w}_2$ and $\underline{p}^d$. The starting values for $\underline{p}^d$ are set to 1. For $\underline{w}_2$ we use the predicted values from a Heckman selection model for the mother's wage as starting values.[11] Note that the solution to the rationing conditions depends on the particular parameter vector considered. Therefore a new reservation wage and price need to be estimated for each rationed household each time the criterion function is evaluated. In practice this means solving for hundreds small minimization problems per evaluation and thousands per iteration. Each minimization problem is a minimum distance step with up to two equations and an equal number of unknowns. The problems are therefore

[9] We minimize the inner product of $[c^{d*} - \underline{c}^d, l_2^*(\underline{w}_2, \underline{p}^d) - \underline{l}_2]'$ if $c^d < \underline{c}^d$ and $m_2 = 0$.

[10] The minimum supplied amount of daycare expenditure $\underline{c}^d$ is set to the equivalent of 4 hours of daycare per child aged 0 to 12 plus 2 hours of daycare per child aged 5 to 12. We evaluate the demand system at a shadow price of daycare consistent with choosing the minimum amount of daycare and not with the price consistent with choosing zero daycare expenditure. The latter price does not exist in our specification as the demand function only tends toward zero as the price of daycare tends to infinity.

[11] We use the mother's age, mother's age squared, education level categories and the number of children as explanatory variables. The number of children is excluded from the wage equation. The model is estimated based on the 2009, 2010 and 2012 sample of two parent households with children. Sensitivity analysis revealed that the choice of starting value for the mother's wage and by extension the specification of the Heckman selection model does not affect the main results.

not particularly complicated. However, due to the sheer number of problems the process is time consuming. We still minimize the nlSUR criterion function of the system of outcomes variables given in equations (3.11) and (3.22).[12] However, each time the criterion function is evaluated we first go through the process of finding shadow prices for all rationed households. Subsequently, we evaluate the predicted values of outcome variables at market or shadow prices as appropriate.

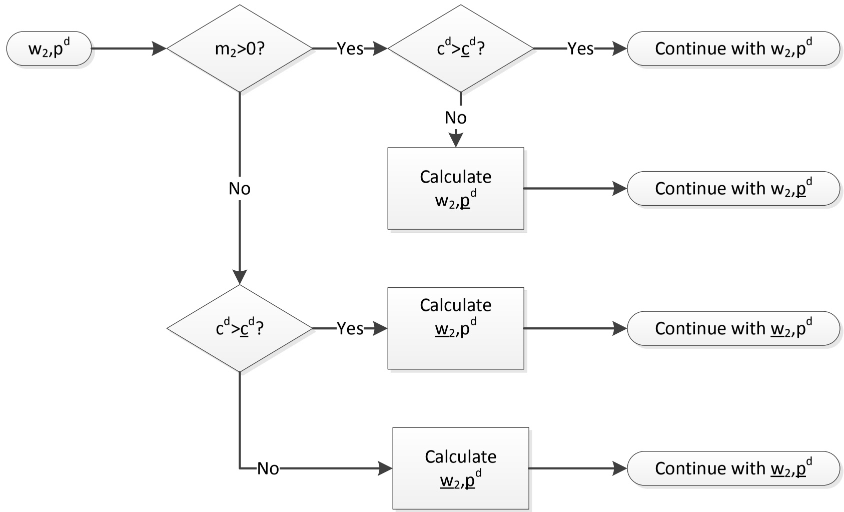
We use global optimization tools available in Matlab's Global Optimization Toolbox to check for the existence of multiple local minima and select the lowest local minimum (in both stages of nlSUR). We estimate based on pooled 2009, 2010 and 2012 data. Standard errors are clustered at the household level.

3.5 Data

In this paper we make use of the survey data developed by Cherchye, de Rock, and Vermeulen (2012b). We use data from the LISS (Longitudinal Internet Studies for the Social sciences) panel administered by CentERdata (Tilburg University, the Netherlands). The LISS panel is a representative sample of Dutch individuals who participate in monthly Internet surveys. The panel is based on a true probability sample of households drawn from the population register. Households that could not otherwise participate are provided with a computer and Internet connection. A longitudinal survey is fielded in the panel every year, covering a large variety of domains including work, education, income, housing, time use, political views, values and personality. Cherchye, de Rock, and Vermeulen (2012b) added the Time use and Consumption module which surveys consumption of several good categories and time use on a comprehensive set of activities. We use the pooled 2009, 2010 and 2012 wave of LISS to estimate our model. The 2012 and 2015 wave are used to predict the effects of changes to the daycare subsidy. We select all two parent households where the husband works regardless of the wife's employment status. We delete households with missing outcome variables or missing explanatory variables (insofar as the latter cannot be imputed from earlier years). Furthermore, we delete households in the top and bottom 1%

[12]We substitute equations (3.16)-(3.20) into equations (3.11) and (3.22). We therefore do not explicitly exploit the two stage budgeting structure when estimating.

Figure 3.3: How shadow prices are determined



of the female and male wage distribution.

In the Time use and Consumption module respondents are asked to recall their household's average monthly expenditure over a year on housing, utilities, transport and means of transportation, insurance, daycare, alimony and child support, servicing debts and loans, cleaning and maintenance of the house and garden and other non-assignable goods. Furthermore, respondents are asked to recall their personal expenditure on food and drinks, tobacco products, clothing, personal care products and services, health care cost not covered by insurance, expenditure on leisure time activities, schooling, donations and gifts, and other assignable goods.[13] Parents are asked to report expenditure on the same categories on behalf of children living at home and younger than 16 years. Older children are asked to report these expenditures themselves. We focus on households where both parents participate in the survey. All households in the sample therefore report expenditure on a set of non-assignable goods, one set of assignable goods for each parent and one set of assignable goods for all children. Furthermore, each parent is asked to recall their time use over the last week on paid work, commuting, household chores, personal care, activities with children, helping parents/other family members/non-family members, leisure time activities, schooling, administrative chores and family finances, sleeping and resting and unnamed activities.

Since we base our model on Cherchye, de Rock, and Vermeulen (2012b) we focus on (almost) the same outcome variables. The exception is that we consider daycare expenditure as an outcome variable in its own right. We use a child expenditure variable which includes all expenditures assignable to the child but excludes daycare expenditure. The remaining outcome variables are the same as in Cherchye, de Rock, and Vermeulen (2012b). We create a public goods category covering expenditure on all non-assignable goods and one private good category for each parent covering all the expenditure assignable to the parent. In Cherchye, de Rock, and Vermeulen (2012b) time use is grouped into four categories. A broad paid work category combines commuting and time actually spend at work. Parental time invested in children is simply the activities with children category mentioned above. Time spent on public goods combines time used for household chores, administrative chores and time used for family finances. The remaining time uses are combined into a broad leisure category. Table 3.1 presents the summary

[13]Food and drinks includes consumption of these goods both at home and outside the home.

statistics for the aforementioned outcome categories.

On average gross daycare cost is about €282 per month over all households and €499 per month conditional on using daycare. Table 3.2 reports the percentage of households using daycare and gross daycare expenditure by the number of children aged 0 to 12. Unsurprisingly, households with more children aged 0 to 12 are more likely to use daycare and have higher daycare cost. Daycare cost do not increase proportionally with the number of children. As a reference point for the figures reported in Table 3.2 consider what amounts to the minimum cost of bringing a child to daycare. At the very least parents can bring their child to daycare for only one afternoon per week. Based on the 2009 maximum hourly price of €6.10 at a minimum a household's gross daycare cost for a single child is about $6.10 * 4 * 52/12 = 105.73$ euro per month. At the other extreme, a couple working full time with overlapping work days may require up to 40 hours of daycare per child. For a single child that works out to ten times the minimum amount. For households with one child of school going age we observe daycare cost of €320, consistent with the child spending on average about 12 hours a week in commercial daycare.

Full income is derived in accordance with Cherchye, de Rock, and Vermeulen (2012b). We obtain full income by taking an individual's personal monthly income multiplying by 168 and dividing by the average weekly real hours worked and commuted from the LISS Work and Schooling module (rather than the paid work category discussed above).[14] We use two measures of non-labor income. The first measure of non-labor income is reported in Table 3.1. It is constructed by adding up the following items from the LISS Income module: Annual non-labor income from savings accounts, stocks, bonds, investment accounts, real estate, student grants and loans, alimony and allowances from family. We add this survey-based version of non-labor income to annualized labor income to construct an initial measure of household income. We apply the subsidy rate schedules presented in Figure 3.1 to the initial measure of household income to obtain the subsidy rate for each household. Subsequently we multiply the subsidy rate with gross daycare expenditure to obtain the total subsidy. Finally, to get the second measure of non-labor income we take total expenditure and subtract total labor income and the daycare subsidy. This expenditure based measure of non-labor income is used as the variable y in the demand system.

We do not observe the price of daycare directly. Instead we use subsidy

[14] A different measure of hours of work is used to avoid division bias.

Table 3.1: Summary statistics, pooled 2009-2012 sample

Variable	Mean	Std. Dev.	Min.	Max.	% zeros
Income (€1000/month)					
Full labor inc. husband	8.43	2.32	2.10	18.18	0
Full labor inc. wife	7.79	2.84	2.00	19.60	0
Non-labor inc. (survey)	0.13	0.40	0.00	5.30	54
Expenditure (€1000/month)					
Private exp. husband	0.35	0.23	0.02	3.06	0
Private exp. wife	0.37	0.26	0.03	3.10	0
Public exp.	1.73	0.63	0.05	4.39	0
Child non-daycare exp.	0.35	0.23	0.01	2.78	0
Gross daycare cost	0.28	0.39	0.00	2.56	43
Time use (1=168 hours)					
Child care husband	0.08	0.05	0.00	0.30	2
Domestic work husband	0.06	0.05	0.00	0.33	2
Market work husband	0.29	0.08	0.11	1.00	0
Leisure husband	0.57	0.09	0.00	0.82	<1
Child care wife	0.14	0.10	0.00	0.51	1
Domestic work wife	0.13	0.09	0.00	0.95	<1
Market work wife	0.13	0.09	0.00	0.59	18
Leisure wife	0.60	0.11	0.03	1.00	0
Demographics					
Children	1.95	0.74	1.00	5.00	0
Children aged 0-4	0.57	0.69	0.00	3.00	54
Children aged 5-12	1.12	0.91	0.00	4.00	28
Mean age children	7.07	3.88	0.00	15.00	1
Gender ratio children[a]	0.50	0.39	0.00	1.00	28
Age husband	40.06	5.75	24.00	60.00	0
Age wife	37.78	0.77	23.00	61.00	0
Higher educ. husband[b]	0.40	0.49	0.00	1.00	60
Higher educ. wife[b]	0.37	0.48	0.00	1.00	63
N			437		

Source: CentERdata, based on own calculations. [a] The child gender ratio is defined as the number of of girls over the number of children. [b] Higher education is a dummy equal to 1 if the respondent completed a higher vocational or university level degree.

Table 3.2: Gross daycare cost conditional on daycare use (€1000/month)

Children age 0-12	Freq.	% using daycare	Mean	Std. Dev.
0^a	29	0		
1	149	51	0.32	0.25
2	195	65	0.49	0.35
3+	64	70	0.81	0.57

[a] These households only have children in the 13 to 15 age group.

rates discussed above to calculate a price of daycare. We make the following assumption: At the margin, daycare use is increased by the same duration for all children. The rationale is that using additional daycare only frees up time for the parents if all children are sent to daycare. Under this assumption we can calculate the marginal subsidy rate for an additional hour of daycare for all children as the unweighted average of the subsidy rates of all children age 0 to 12. The marginal subsidy rates for households without children age 0 to 12 and one earner households are set to zero. The price of daycare is calculated as the product of the maximum hourly price of daycare and one minus the marginal subsidy rate. The average marginal subsidy rate conditional on eligibility for the subsidy is equal to 86% in the 2009 wave, 87% in the 2010 wave, 79% in the 2012 wave and 75% in 2015. Note that these average marginal subsidy rates are not directly comparable to the average subsidy rates in Figure 3.2(a), due to the assumption that daycare use is increased by the same duration for all children. The maximum hourly price of daycare was €6.1 in 2009, €6.25 in 2010, €6.36 in 2012 and €6.85 in 2015.

Households are asked to supply information about the birth year, gender and living at home status for each of the children born to, adopted by or under foster care of either parent. In some cases such data is missing. We impute missing data for a child from previous years if the child has not passed away. Moreover, we impute from subsequent years if this results in a non-negative age for a child and data from previous years is not available. For imputation purposes we use all waves of LISS between 2009 and 2016. Variables such as the mean age of children or number of children in an age group are calculated based on the imputed data rather than imputed directly themselves.

As in Cherchye, de Rock, and Vermeulen (2012b) we allow heterogeneity with respect to age in preferences for private consumption-leisure. As sharing rule variables we use the ratio of full labor income of the wife to full labor income of the husband, non-labor income based on survey data, the husband-wife age difference and an higher education dummy for both the husband and the wife. Higher education dummies are equal to 1 if the respondent has completed a degree at the university or higher vocational education level. As production shifters we use the number of children, mean age of children and, a child gender ratio. The child gender ratio is defined as the number of of girls over the number of children.

3.6 Results

3.6.1 Estimation results

We start this section with some average results for the sample and subsequently discuss the underlying estimates. Table 3.3 presents the sample average estimate of the husband's average share of resources and the sample average elasticities of substitution for the inputs in the household production functions.

The husband's share is estimated at approximately 56%. Interestingly, the results suggest that the man controls more than half of full expenditure on average. This result is quite different from studies which focus only on consumption expenditure. Studies such as Browning, Chiappori, and Lewbel (2013) and Cherchye, de Rock, and Vermeulen (2012a) find that women control more than half of the resources in a household. It is reassuring to find that our figure is close to the 54% share found in Cherchye, de Rock, and Vermeulen (2012b), given the overlapping data.[15]

The elasticities of substitution for the three production functions are given by $1/(1-\epsilon^j(\mathbf{s}))$ for $j = k, p, pc$. The sample average estimate of the elasticity of substitution for the domestic good is 1.17, which is close to 1.18 figure found in Cherchye, de Rock, and Vermeulen (2012b). Substitutability is

[15]There are large differences in terms of sample selection with respect to Cherchye, de Rock, and Vermeulen (2012b). We are able to use the 2009, 2010 and 2012 waves of the Time use and Consumption module whereas Cherchye, de Rock, and Vermeulen (2012b) is based on the 2009 wave. We include households where the mother does not participate in the labor market. However, we are more selective with respect to the age of children in the households. We only include households where are living at home children are younger than 16.

equally high amongst the inputs of the child welfare function (1.17) and somewhat higher between maternal and paternal child care (1.29).

Table 3.3: Main results

Measure	Mean		Std.Dev.
Expenditure share father Λ	0.5624		0.0946
Elasticity of substitution			
Child care $1/(1-\epsilon^k)$	1.1662		0.0709
Public good $1/(1-\epsilon^p)$	1.1642		0.0705
Parental care $1/(1-\epsilon^{pc})$	1.2920		0.0433
Criterion value		4198.51	
N		437	

The full set of estimates is presented in Tables 3.4 and 3.5. These are the second stage estimates of nlSUR estimation of the system given in equations (3.11) and (3.22). In Table 3.4 we find estimates of the leisure-consumption preference parameters appearing in equation (3.11). We see that the estimate of β_1 (the slope of the leisure budget share) is insignificant. This indicates that for fathers the division of the individual budget between private consumption and leisure does not vary significantly with the size of his individual budget. β_2 is significant and negative, indicating that for mothers the share of the individual budget going to leisure decreases with the size of her individual budget. Older parents spend a larger share of their budget on leisure ($\alpha_i^{1,i}$), though the effect is smaller and insignificant for fathers.

Turning to the sharing rule estimates reported in Table 3.4 we find that the maternal to paternal wage ratio has the expected negative relation to the father's resource share. The effect is significant and substantial. The average marginal effect of standard deviation increase (+0.5401) on the father's expenditure share equals $-0.1782 \cdot 0.5401 = -0.0963$ or a 9.6 percentage point decrease. Controlling for relative wages, none of the other sharing rule variables significantly affects the father's expenditure share. Note that the predicted effects of household non-labor income and the two education dummies are simply quite small and not especially imprecisely estimated. The average marginal effects of these variables are smaller than 1 percentage point.

Table 3.5 reports estimates of the parameters in the production functions for child utility, the domestic good and parental care sub-utility function. There are two things to note about the input productivity (γ) parameters.

Table 3.4: Preferences and sharing results

Parameter		Estimate	Std.Err.	AME[a]
Preferences				
$\alpha_1^{1,0}$	Constant	0.9230	0.0161	
$\alpha_1^{1,1}$	Age husband/10	0.0021	0.0036	
$\alpha_1^{0,k}$	Child welfare	-1.6807	0.1290	
$\alpha_1^{0,p}$	Public good	-0.9911	0.0958	
β_1	Slope	-0.0155	0.0149	
$\alpha_2^{2,0}$	Constant	0.8785	0.0367	
$\alpha_2^{2,1}$	Age wife/10	0.0145	0.0052	
$\alpha_2^{0,k}$	Child welfare	-1.8943	0.1896	
$\alpha_2^{0,p}$	Public good	-1.7732	0.2103	
β_2	Slope	-0.1146	0.0295	
Sharing rule				
λ^1	Constant	0.9146	0.0692	
λ^2	w_2/w_1	-0.7495	0.0380	-0.1782
λ^3	Non-labor income (€1000/month)	-0.0223	0.0162	-0.0053
λ^4	Age difference/10	0.1123	0.1305	0.0264
λ^5	Educ husband[b]	0.0148	0.0306	0.0035
λ^6	Educ wife[b]	0.0283	0.0263	0.0067

[a] Average marginal effect on the husband's expenditure share. [b] Higher education is a dummy equal to 1 if the respondent completed a higher vocational or university level degree.

First, the $\gamma_{2,1}^k$ ($\gamma_{2,2}^k$) gives the productivity of daycare expenditure per child age 0 to 4 (age 5 to 12). Productivity of daycare is about twice as high for children age 0 to 4 than for children age 5 to 12. Second, within the parental care utility function productivity parameters are poorly determined. We cannot conclude whether the paternal and maternal time input are about equally productive. With regard to the elasticity (ϵ) parameters we note that parental time inputs and expenditure inputs become poorer substitutes when there are more or older children in the household.

3.6.2 Effects of the daycare subsidy

Table 3.6 reports the predicted effects of the change from the 2010 to the 2012 daycare subsidy. The "predicted" column compares the 2012 model predic-

Table 3.5: Productivity and substitutability results

Parameter		Estimate	Std.Err.
Productivity parameters			
γ_1^k	Parental care	0.7558	0.2961
$\gamma_{2,1}^k$	Nr. kids 0 to 4*daycare exp.	0.0385	0.0175
$\gamma_{2,2}^k$	Nr. kids 5 to 12*daycare exp.	0.0186	0.0089
γ_3^k	Non-daycare child exp.	0.4103	0.1882
γ_1^p	Paternal domestic work	0.1442	0.0456
γ_2^p	Maternal domestic work	0.2719	0.0833
γ_3^p	Public good exp.	0.3843	0.1383
γ_1^{pc}	Paternal child care	2.1782	2.5474
γ_2^{pc}	Maternal child care	2.9573	3.3347
Substitution elasticity parameters			
ϵ_0^k	Constant	0.3002	0.1620
ϵ_1^k	Nr. children	-0.0514	0.0274
ϵ_2^k	Age children/10	-0.0745	0.0492
ϵ_3^k	Gender ratio children	-0.0154	0.0240
ϵ_0^p	Constant	0.3002	0.0962
ϵ_1^p	Nr. children	-0.0506	0.0156
ϵ_2^p	Age children/10	-0.0741	0.0287
ϵ_3^p	Gender ratio children	-0.0219	0.0222
ϵ_0^{pc}	Constant	0.3016	0.1854
ϵ_1^{pc}	Nr. children	-0.0165	0.0140
ϵ_2^{pc}	Age children/10	-0.0510	0.0424
ϵ_3^{pc}	Gender ratio children	-0.0161	0.0217

tions to the model predictions under the counterfactual that 2010 rules still apply in 2012. The values in this column are found by taking the difference between the prediction using 2012 prices and the prediction using the 2010 prices and averaging over all households which receive the daycare subsidy in 2012. The "actual" column contains the observed mean difference in outcome variables for households which received the subsidy in both 2010 and 2012. This is the only comparison data available in our sample. The values should be interpreted with care. In contrast to the "predicted" column the values in the "actual" column reflect not only the effect of the policy change. They also reflect the effect of children and parents aging and changes in other observed and unobserved variables.

We first focus on the observed changes in time use for treated households reported in column 2 of Table 3.6. Paternal labor supply decreases by 1.8 hours and paternal leisure time decreases by 0.3 hour a week. This time is reallocated to child care and domestic work. Maternal domestic work decreases by 1.8 hours and maternal leisure time decreases by 2.5 hours a week. The increase in maternal market work may seem surprising at first. Note though that we are comparing households that appear in both 2010 and 2012. All households members have therefore aged 2 years. Assuming older children require less care, then time is freed up for market work or alternatively domestic work or leisure.[16] Furthermore, all time use differences for the treated group reflect selection effects to some extent. Mean differences reflect the characteristics of households that start/stop using daycare and where the wife starts/stops working. The predictions for time reallocation match the sign, but not the magnitude, of the changes in paternal paid work, child care and leisure time and maternal child care. We predict that market work is increased by just a few minutes per week. This finding is consistent with the findings of Jongen, de Boer, and Dekker (2014), who predict a very modest increase in hours worked due to 500 million euro increase in daycare subsidy outlays. This comparison is especially relevant since the Jongen, de Boer, and Dekker (2014) model was estimated based on 2006-2009 data, a period when the subsidy rate increased, whereas our model is estimated based on 2009-2012 data, a period when the subsidy rate declined. The response in terms of hours worked appears to be roughly symmetrical with respect decreases and increases in the subsidy.

For treated households in 2012, the average daycare price according to 2010 rules is 0.1326 which increases to 0.2026 if 2012 rules are applied. The average daycare price is thus 53% higher in 2012 than under the counterfactual. As a result of the increased daycare price we predict gross daycare expenditure is reduced by on average €232 a month amongst treated households, consistent with about 36 child-hours a month. This amounts to a 42% reduction in gross expenditure with respect to the amount they would have spent had the 2010 rules still applied. Household with one, two and three or more children aged 0 to 12 on average reduce gross daycare expenditure by respectively €45, €209 and €435 a month. The predicted average reduction of €232 is substantially larger than the observed €149 reduction for households appearing in both 2010 and 2012 (column 2). The predicted effect

[16]Of course new children may be born in the interim. However, it is almost as likely that a child either matures, moves out or passes away.

on net expenditure is much more modest at €3 a month. Two effects are at work. Evaluated at constant daycare use levels the price increase results in a €26 a month increase in expenditure net of subsidies. However, the aforementioned reduction in expenditure gross of subsidies results in a €29 a month reduction in expenditure net of subsidies.

Parents reallocate part of the decrease in net daycare expenditure to other child expenditures, a substitute for daycare in child welfare. Predicted changes in child expenditure only explain a small portion of observed changes between 2010 and 2012. As a result of the decline in the daycare subsidy we predict that both parents work less on average and reallocate time to child care and to a lesser extent leisure time. Parental domestic work is unaffected by the policy change. Note that mothers adjust their time more than fathers, a common finding in the daycare cost and labor supply literature. Finally, since parents reduce their time in market work slightly the budget available for all types of consumption decreases. As a result parental private expenditure is reduced. Note that we again predict a stronger adjustment of the mother's outcome than the father's outcome.

In Table 3.7 we report predicted changes for the 2015 subsidy change. We once again compare model predictions for 2015 under the 2015 regime with predictions of the counterfactual that the 2010 regime still applies. Contrary to the predicted effects for the 2012 subsidy change, the predictions for the 2015 subsidy change are out-of-sample predictions. Note that, we do not observe the actual mean difference between 2010 and 2015 for the several outcome variables. The 2015 wave of the TuC module no longer contained the full set of questions about private consumption expenditure and time spent on domestic work or leisure. We only present the predicted policy effects for these variables and cannot validate these predictions.

The predicted effects of the subsidy changes are qualitatively the same as the 2012 effects. All predicted effects are slightly stronger in 2015 than in 2012, reflecting the additional decrease in the daycare subsidy with respect to 2012. Daycare expenditure is €264 lower under 2015 rules than under 2010 rules, consistent with about 40 child-hours a month. This amounts to a 47% reduction in gross expenditure with respect to the amount they would have spent had the 2010 rules still applied.

Table 3.6: Predicted policy change effect on treated households[a] in 2012

Variable	Predicted	Actual
Time use (hours)		
Market work husband	-0.03	-1.79
Child care husband	0.02	0.87
Domestic work husband	0.00	1.27
Leisure husband	0.00	-0.35
Market work wife	-0.06	3.48
Child care wife	0.03	0.89
Domestic work wife	0.00	-1.85
Leisure wife	0.03	-2.51
Expenditure (€1/month)		
Gross daycare	-231.6	-148.8
Net daycare	-3.4	
Child expenditure	0.7	104.2
Public good expenditure	0.0	157.5
Husband private expenditure	-0.2	11.3
Wife private expenditure	-1.3	26.5

[a] Treated means that a household contained children age 0 to 12, both parents worked, and the households consumed daycare in 2012.

3.6.3 Discussion

The model predictions discussed above likely raised at least two questions. First, why are all time use and expenditure responses so small while the subsidy cut is large? Time reallocation amounts to a matter of minutes rather than hours and expenditure reallocation amounts to less than a percent of the average household budget. Second, if daycare use is reduced by 42% (which is what a reduction in gross expenditure reflects) while there is no strong compensatory increase in parental child care time then would the child's welfare not be strongly negatively affected? In terms of the model's estimates both questions can be explained with reference to the productivity parameters in Table 3.5. Note that the productivity parameters for gross daycare expenditure ($\gamma^k_{2,1}$, $\gamma^k_{2,2}$) are quite low compared to the productivity parameter on other child expenditures (γ^k_3). This implies that a household can reduce gross daycare expenditure considerably and increase other child expenditures only a little while keeping child utility constant. Similarly only

Table 3.7: Predicted policy change effect on treated households[a] in 2015

Variable	Predicted	Actual
Time use (hours)		
Market work husband	-0.03	-1.30
Child care husband	0.02	0.69
Domestic work husband	0.00	
Leisure husband	0.00	
Market work wife	-0.06	5.32
Child care wife	0.04	1.56
Domestic work wife	0.00	
Leisure wife	0.03	
Expenditure (€1/month)		
Gross daycare	-263.5	45.1
Net daycare	-4.2	
Child expenditure	0.8	-3.4
Public good expenditure	0.0	-1.9
Husband private expenditure		
Wife private expenditure		

[a] Treated means that a household contained children age 0 to 12, both parents worked, and the households consumed daycare in 2015.

small increases in parental child care time are needed to compensate a reduction in daycare use. Time use and expenditure responses to the subsidy cut need not be large to keep child utility constant. Most households compensate the child welfare loss due to a reduction in daycare expenditure to a considerable extent. Nonetheless, all family members are harmed by the policy change.

While the relative unimportance of daycare expenditure in our estimates may simply reflect reality, it may also point to a weakness of the model. The model is unable to explain who is looking after the children if not the parents or a commercial daycare provider. It seems likely that the current model is missing some aspects of child care. One such aspect is the availability of informal child care. Specifically, free child care by family members (outside the household) or arrangements with other parents to look after each others children. Daycare may simply have low productive efficiency relative to unobserved lower cost alternatives. This could explain the low productivity of daycare we find in our estimates. We do not have high quality data on such alternatives, but expect them to play some role.

3.7 Conclusion

We use a collective model of household consumption, time use and child care based on the model of Cherchye, de Rock, and Vermeulen (2012b) to evaluate the effect of a series of child care subsidy cuts in the Netherlands. The base model is adjusted to account for non-participation in the labor market by the mother and non-participation in the commercial child care system by the household. The household objective function is a weighted sum of parents' utility. The level of daycare expenditure, in addition to parental care and non-daycare child expenditure, enters a household production function for the children's welfare, which in turn affects both parents' utility functions. The model is estimated based on a sample of households including both working and non-working mothers and households which do and do not use commercial child care. Data comes from the 2009-2015 waves of the Longitudinal Internet Studies for the Social sciences panel administered by CentERdata (Tilburg University, The Netherlands). Within this time period there were two major adjustments to the child care subsidy rate in 2012 and 2013. The average parental share of daycare cost rose from 22% in 2010 to 33% in 2012 and 40% in 2013. We use our estimated model to predict the effect of replacing the 2010 regime with the 2012 and 2015 regimes using data from the latter two years.

In line with the reduction in the overall cost of the subsidy our model predicts a strong reduction in daycare use. Gross-of-subsidy daycare expenditure is reduced substantially by €231 a month in 2012 for households using daycare corresponding to about 36 child-hours a month. We predict that in 2015 gross-of-subsidy expenditure is reduced by an additional €32 a month with respect to 2012. The effect on net-of-subsidy daycare expenditure is predicted to be negligible, as are the effects on private and public expenditure. While the cost of daycare to parents increased substantially in 2012 and 2013, we predict reallocation of time from market work to other time uses of only a couple of minutes per week by either spouse. Time is reallocated mainly to parental child care and to a lesser extent parental leisure time. Changes to the daycare subsidy rate thus have strong intensive margin effects on commercial daycare use but only very modest intensive margin effects on labor supply by parents. The latter effect is roughly consistent with the findings of Bettendorf, Jongen, and Muller (2015). They find that during the 2005-2009 period when the generosity of the Dutch child care subsidy increased substantially there were only modest increases in female employment rate and hours worked.

Whilst the combination of a strong reduction in subsidy payments with a nearly non-existent labor supply response by either parent may seem like good news for policy makers, the results should be interpreted with data and modeling limitations in mind. First, the modest time use responses may well reflect that the choice of hours worked is in reality limited to a discrete set of choices. While the increase in daycare cost is substantial it may not be enough to sharply reduce hours worked. Finding no labor supply response may imply that parents do not have the option to reduce their work hours. Second, we focus on the contribution of parental child care hours to child welfare. However, a better approach may be to consider the dis-utility that children receive from hours they are not being cared for. We do not take this approach because we do not observe daycare use in terms of hours or whether parental child care hours overlap. We are not therefore not explicitly "punishing" the parents (or children) for leaving their children unattended.

The flip side of the result discussed above is that we predict that parents reduce daycare expenditure strongly and do not make up for the shortfall in commercial child care hours by increasing their own child care hours. If indeed children are left unattended then the policy change affects them negatively. This is in fact what the model predicts. However, it seems more likely that children receive informal care instead. We did not model the demand for informal care due to data limitations.[17] It is therefore possible that parents that do not adjust their own child care hours do so because they can substitute formal care by informal care. For example, they could be relying on grandparents or other trusted family and friends for child care. The reduction of the daycare subsidy at first appears successful because it reduces the cost of the program while having a limited effect on parental labor supply (along the intensive margin). However, the true cost of the subsidy cut may be paid by informal care providers if informal care is unrewarded or by parents if informal care is rewarded. One of the goals of the 2012-2013 subsidy cuts was to decrease the share of daycare cost paid by the government and by increasing the share paid by parents. If the latter are shifting these

[17]The LISS data does contain some information on informal care use, but not enough to establish the price of informal care or total expenditure on informal care.

costs on towards family or friends, then this can be seen as an unintended consequence of the policy change. The extent to which a reduction in child care subsidies or availability leads to an increase in the child care burden by non-parents is an interesting avenue for future research. Such a study would require new data combining time use diaries or surveys with information on informal care use and costs. Finally, a limitation of the study is that parents are asked to report only one main activity at each point in time. However, parents can combine household work or leisure with child care. It is possible that in response to the daycare subsidy cut parents started combining child care with domestic work or leisure more often. The data does not allow us to study whether this is the case. A time use diary, allowing overlapping activities, could potentially produce data that is better fitted to addressing the type of questions discussed in this paper.

Chapter 4

Individual Consumption Inequality in the Netherlands.[1]

4.1 Introduction

Consumption expenditure is possibly the most important contributor to individual economic welfare. In fact consumption is considered so important that (absolute) poverty is often defined as a state of inadequate consumption expenditure. It has been argued (see e.g. Barrett, Crossley, and Worswick 2000 or Deaton and Zaidi 2002) that consumption is a good proxy for lifetime resources since individuals smooth consumption over time (see e.g. Deaton 1991). Hence inequality in consumption is seen as a problem of major significance. While concern with consumption inequality may depend on a person's political leaning, high inequality has implications that few would not be concerned with to at least some extent. For a given level of average consumption, an increase in consumption inequality will increase the shares of the population at risk of poverty or social exclusion. Despite public concern with the issue we do not in practice measure consumption inequality in a way consistent with economic theory. Economic theory suggests that individual consumption (as opposed to household consumption) is an input to individual economic welfare and should therefore be of relevance to policy makers. However, historically studies of consumption inequality have focused on inequality in household consumption. The focus on household rather than individual consumption reflects a number of limitations that these studies

[1] This study represents joint work with Rob Alessie and Jochem de Bresser.

faced. First, data about consumption was usually collected at the household level. Second, collective models that explained households' decisions as the interplay between multiple household members had not yet been developed. The rejection of income pooling in (amongst many others) Blumberg (1988), Bourguignon et al. (1993), and Browning, Bourguignon, et al. (1994) point to the importance of such models. Third, individual expenditure levels of members of different household types are not comparable due to economies of scale in household size. Previous studies could at best control for economies of scale by dividing expenditure by equivalence scales. Browning, Chiappori, and Lewbel (2013) argue against the use of equivalence scales since these are based on equivalence between households of different types in terms of the ill-defined concept of household utility. Furthermore, equivalence scales that are used in practice, such as the OECD scales, are something of a black box.

In this paper we study consumption inequality at the individual level for the years 2009-2017. We address the aforementioned three problems that earlier contributions to the literature faced. The data problem is addressed by using Dutch data from the Longitudinal Internet Studies for the Social sciences (LISS) panel Time Use and Consumption module, a dataset with unusually detailed individually assignable consumption expenditure data, coupled with household level expenditure data on fundamentally non-assignable goods and time use data for adult household members. This dataset was first used in Cherchye, de Rock, and Vermeulen (2012b). The issue of modeling decision making in multiple person households has been addressed in the collective modeling literature. Of particular relevance are the seminal cooperative model of Chiappori (1988, 1992), the Blundell, Chiappori, and Meghir (2005) collective model with children and the application of the latter model in Cherchye, de Rock, and Vermeulen (2012b). We estimate a modified version of the collective model with household production of Cherchye, de Rock, and Vermeulen (2012b). The model is extended to cover not only two-parent households but also couples without children, single person households and single parents. We use the model to derive a measure which we call Singles Equivalent Full Individual Consumption (SEFIC hereafter). SEFIC is the level of consumption a member of multiple person household needs in order to be equally well of living alone or as a part of their current household. The concept is closely related to an indifference scale in the spirit of Browning, Chiappori, and Lewbel (2013). SEFIC compensates members of multiple person households for loss of the economies of scale they benefit from in their current household. In this study we model the source of economies of scale in consumption. We assume that households produce public goods, which larger households can share amongst more members. This approach allows economies of scale to vary with household size, the number of children, the children's ages and potentially (other) factors related to productivity within the household. Because it compensates for economies of scale, SEFIC is comparable across household members of different household types. However, it is not comparable between men and women unless we impose that they have the same preferences and are equally productive in domestic work. The former assumption is routinely rejected in the literature. We reject both assumptions in this paper. We therefore construct inequality measures both at the population level and for men and women separately. We use the estimated model to calculate SEFIC and inequality therein for the 2009, 2010, 2012, 2015 and 2017 waves of the Time Use and Consumption module, which allows us to study changes in consumption inequality during the Great Recession.

The paper is related to literature that examines the relation between earnings or income inequality and consumption inequality at the household level. Relevant studies are Blundell and Etheridge (2010) for the UK, Brzozowski et al. (2010) for Canada, Heathcote, Perri, and Violante (2010) for the US and Jappelli and Pistaferri (2010) for Italy. More recent contributions such as Heathcote, Storesletten, and Violante (2014) and Blundell, Pistaferri, and Saporta-Eksten (2016) explore these issues in the context of a life-cycle model. One goal of this paper is to compare income and consumption inequality when the latter is measured at the individual rather than household level.

The paper is closely related to Lise and Seitz (2011) who used a collective model to estimate consumption inequality at the individual level for the United Kingdom. Lise and Seitz (2011) showed that the existence of intra-household inequality had important implications for both the level and trend in consumption inequality. An approach that ignores intra-household inequality underestimates the level of consumption inequality by as much as 50% in 1968 relative to an approach that includes intra-household inequality. Furthermore, the upward trend in inequality between 1968 and 2001 is overestimated. Lise and Seitz (2011) initially focus on consumption expenditure in terms of market goods. However, they also consider inequality in terms of full expenditure meaning expenditure on goods plus the value of time not spent at work. In either case, their approach is to estimate a collective model and impute from that model the share of private goods each member of a couple consumes. To each member's private consumption they add household public consumption to get an individual consumption level. We can (and do) calculate the same consumption metric without imputing private consumption because we observe private consumption, public consumption and leisure directly. In our main analysis we introduce two innovations relative to the approach of Lise and Seitz (2011). First, whereas Lise and Seitz (2011) analyze consumption inequality for a combined sample of single persons and members of couples without children we extend the analysis to members of couples with children living at home. Second, Lise and Seitz (2011) are agnostic about the source of economies of scale whereas in this paper the source of economies of scale is modeled. In this paper economies of scale arise from production of domestically produced public goods which can be shared amongst more members in larger households. These are child utility produced by parental child care, child expenditures and a domestic good produced by household work and expenditure on goods such as housing and utilities. The analysis of SEFIC inequality is similar to the analysis of full expenditure in Lise and Seitz (2011). However in our case, time not spent at work is split into leisure time, time used for domestic work and time used for childcare which have different effects on the level of SEFIC. Comparing the two approaches, we find that the SEFIC approach results in a significantly higher level of inequality, but no significant differences in terms of the trend.

This paper is also related to Han, Meyer, and Sullivan (2018), who analyze (household level) consumption and leisure inequality in the US over the past four decades in the Consumer Expenditure Survey. Similar to our approach Han, Meyer, and Sullivan (2018) estimate a model for consumption and leisure from overlapping time use and consumption data. They then use their estimated model to simulate leisure inequality for larger scale consumption data. The main difference with Han, Meyer, and Sullivan (2018) is that we use a structural model of household production. Where Han, Meyer, and Sullivan (2018) produce only separate inequality series for consumption and leisure, we can produce separate inequality series for consumption, leisure and household production. Moreover, we can construct SEFIC inequality, a single measure of welfare inequality which incorporates inequality in consumption, leisure and household production.

We find that individual consumption inequality in the Netherlands rose significantly between 2009 and 2010 and fell significantly during the later recession years 2010-2012. The results suggest that consumption inequality then rose from 2012 to 2015, and fell between 2015 and 2017. As in Lise and Seitz (2011) we decompose consumption inequality into variation within households and between households. With respect to Lise and Seitz (2011), we further decompose variation between households into variation between households but within household types and variation between household types. Changes in consumption inequality in the Netherlands between 2009 and 2017 appear to be driven primarily by changes in variation between households but within household types, and to a lesser extent by changes in variation between household types. Changes in variation within households do not play an important role. The level of inequality amongst men appears to be higher than amongst women. However, we cannot reject the hypothesis that these levels are equal. Individual consumption inequality is significantly higher than inequality in equivalent household expenditure, despite the fact that within-household inequality is not very high. This is possible because we estimate that there are large differences in economies of scale between household types. Inequality in individual consumption inequality and equivalent household expenditure follow qualitatively the same pattern over time. The results are robust to reweighing the 2009-2017 samples to the distribution of household types (as well as the age and education distribution) amongst the Dutch population in 2009.

The paper is structured as follows. Section 2 introduces the model and derives an equation for SEFIC. Section 3 discusses the Time Use and Consumption module of LISS which is used to estimate the model and construct inequality series. Section 4 discusses how each of the inequality series are constructed. The details of estimation and the estimation results are relegated to the Appendix. Section 5 discusses the distribution of SEFIC and the evolution of SEFIC inequality and its components over time. Section 6 contains some concluding remarks.

4.2 The model

The model used to determine singles individual consumption equivalents is a modified version of the collective model with household production of Cherchye, de Rock, and Vermeulen (2012b). This section presents the model, highlighting differences with Cherchye, de Rock, and Vermeulen (2012b).

Here we present only the two-stage budgeting representation of the model for couples with children. We represent the household's allocation process as one where in the first stage the parents allocate the household's total budget to public consumption, to children's consumption, and to each parent's individual second stage budget. In the second stage the father and mother can individually decide how the budget they received in the first stage should be allocated between consumption and leisure. We later discuss how the model for singles, childless couples and single parents differ from the model for couples with children.

If v_1 and v_2 are the indirect utility function of respectively an adult man and an adult woman in a couple, then a couple household maximizes the objective function

$$V = \Lambda_1(\mathbf{z})v_1(x_1, w_1, p_a; u^p, u^k, \mathbf{d_1}) + \Lambda_2(\mathbf{z})v_2(x_2, w_2, p_a; u^p, u^k, \mathbf{d_2}) \quad (4.1)$$

subject to the household budget constraint

$$x \equiv x_1 + x_2 + G^k u^k + G^p u^p = w_1 + w_2 + y, \quad (4.2)$$

where x is household full expenditure, x_i is individual full expenditure on private consumption and leisure by $(i = 1)$ the adult man or the adult woman $(i = 2)$ in the household, w_i is potential net labor income of individual $i = 1, 2$ (or the after-tax value of the time endowment), y equals household non-labor income minus (net) saving, p_a is the price of private consumption, $\mathbf{z}$ and $\mathbf{d_i}$ are vectors of variables discussed below, u^k and u^p are the production levels of two forms of domestic production discussed below, G^k and G^p are the unit costs of aforementioned domestically produced goods, and $\Lambda_1(\mathbf{z})$ and $\Lambda_2(\mathbf{z}) = (1 - \Lambda_1(\mathbf{z}))$ are the Pareto weights on respectively the man and woman.[2] In words the equivalence in equation (4.2) says that full household expenditure x is the sum of (full) expenditure on private consumption, leisure and the domestically produced goods. Throughout the paper we assume that households engage in intertemporal two-stage budgeting. The level of household full expenditure is thus assumed to be an optimal choice from a life cycle perspective. This implies that $x = w_1 + w_2 + y$. Potential net labor income w_i is the after-tax income someone would receive if they were to work non-stop at their current wage. In other words, it is the value of someone's

[2] Due to a limited subsample size we do not include same sex couples in this analysis.

time endowment. Individual full expenditure is the expenditure on private goods plus the value of their leisure time at their after-tax wage. The vector $\mathbf{d_i}$ contains a number of taste shifters for parent i. We use the parent-specific age in years and a higher education dummy below. The latter equals 1 when the respondent has completed a degree in the Dutch higher education system (at the higher vocational education or university level).

In Cherchye, de Rock, and Vermeulen (2012b) the household produces a domestic good u^p according to the CES production function

$$u^p = \left[\gamma_1^p \left(h_1^p\right)^{\epsilon^p(\boldsymbol{s})} + \gamma_2^p \left(h_2^p\right)^{\epsilon^p(\boldsymbol{s})} + \gamma_3^p \left(c^p\right)^{\epsilon^p(\boldsymbol{s})}\right]^{\frac{1}{\epsilon^p(\boldsymbol{s})}}, \tag{4.3}$$

where h_1^p, h_2^p are paternal and maternal hours of domestic work and c^p is real expenditure on public goods. Associated with c^p we have the price p_{na}. The vector $\mathbf{s}$ contains the households production shifters, which are the number of children and mean age of children. The level of child utility u^k is also assumed to be produced by means of parental inputs. It follows the production function

$$u^k = \left[\gamma_1^k \left(\frac{h_1^k}{n}\right)^{\epsilon^k(\boldsymbol{s})} + \gamma_2^k \left(\frac{h_2^k}{n}\right)^{\epsilon^k(\boldsymbol{s})} + \gamma_3^k \left(\frac{c^k}{n}\right)^{\epsilon^k(\boldsymbol{s})}\right]^{\frac{1}{\epsilon^k(\boldsymbol{s})}} \tag{4.4}$$

where n is the number of children living at home, h_1^k, h_2^k are paternal and maternal hours of child care time, c^k is real child expenditure. Associated with c^p we have the price p_a. This is the same price associated with private consumption by the parents.[3] The prices p_a and p_{na} are normalized to one in 2015. The specification differs from Cherchye, de Rock, and Vermeulen (2012b) in that we use inputs per child (e.g. h_1^k/n instead of h_1^k). The level of child utility u^k can be interpreted as average child utility assuming that resources are distributed equally amongst children.

We need to impose that $0 < \epsilon^k(\mathbf{s}) < 1$ and $0 < \epsilon^p(\mathbf{s}) < 1$ for all households. In practice we impose

$$0.1 < \epsilon^{0,k} + \epsilon^{1,k}\ln(s_1^{min}) + \epsilon^{2,k}\ln(s_2^{min}) < 0.9 \tag{4.5a}$$
$$0.1 < \epsilon^{0,k} + \epsilon^{1,k}\ln(s_1^{min}) + \epsilon^{2,k}\ln(s_2^{max}) < 0.9 \tag{4.5b}$$
$$0.1 < \epsilon^{0,k} + \epsilon^{1,k}\ln(s_1^{max}) + \epsilon^{2,k}\ln(s_2^{min}) < 0.9 \tag{4.5c}$$

[3] In the application child and parental private consumption consist of the same (assignable) categories, e.g. food, clothing and personal care products.

$$0.1 < \epsilon^{0,k} + \epsilon^{1,k}\ln(s_1^{max}) + \epsilon^{2,k}\ln(s_2^{max}) < 0.9, \tag{4.5d}$$

and similarly for the domestic good, where s_1^{min} and s_1^{max} are respectively the minimum and maximum observed value of s_1 in our data. The $0.1 < \epsilon^k$ inequalities in equations (4.5a)-(4.5d) guarantees concavity of the production level in the inputs. The $\epsilon^k < 0.9$ inequality is imposed to avoid numerical problems that occur when evaluating the system from poor starting values.[4]

We do not make assumptions about the process of bargaining and instead estimate the resulting male Pareto weight $\Lambda(\mathbf{z})$ with a reduced form. We assume that the Pareto weight is given by

$$\Lambda_1(\mathbf{z}) = \frac{\exp(\lambda'\mathbf{z})}{1+\exp(\lambda'\mathbf{z})}, \tag{4.6}$$

where $\mathbf{z}$ contains an education dummy for both parents as well as a set of distribution factors; variables which are assumed to affect the Pareto weight but not preferences (or productivity in household work). As distribution factors we use relative potential labor income defined as $w_1/(w_1+w_2)$, the wife-husband age difference and a married dummy.

As in Cherchye, de Rock, and Vermeulen 2012b, parental indirect utility is given by a simplified version of the Deaton and Muellbauer (1980) Almost Ideal Demand System indirect utility function:

$$v_i(x_i, w_i, p_a; u^p, u^k, \mathbf{d_i}) = \frac{\ln(x_i) - \ln a_i(w_i, p_a; u^p, u^k, \mathbf{d_i})}{b_i(w_i, p_a; \mathbf{d_i})} \qquad \text{for } i = 1, 2. \tag{4.7}$$

We specify

$$\begin{aligned} \ln a_i(w_i, p_a; u^p, u^k, \mathbf{d_i}) &= \left[\alpha_i^0 + \alpha_i^{0,k}\ln u^k + \alpha_i^{0,p}\ln u^p\right] + \ln p_a \qquad (4.8a) \\ &\quad + \left[\alpha_i^i(\mathbf{d_i}) + \alpha_i^{i,k}\ln u^k + \alpha_i^{i,p}\ln u^p\right]\ln\frac{w_i}{p_a} \\ b_i(w_i, p_a; \mathbf{d_i}) &= \left(\frac{w_i}{p_a}\right)^{\beta_i(\mathbf{d_i})}, \qquad (4.8b) \end{aligned}$$

The adding-up restrictions for the consumption-leisure system are implicitly imposed in the specification of $\ln a_i$ and b_i.

To ensure that there is an increasing relation between parental utility v^i

[4]The final exponents in equations (4.3) and (4.4) tend to infinity as $\epsilon^p, \epsilon^k \to 0$. The same problem occurs in later equations, e.g. equation (4.13) and (4.14), when $\epsilon^p, \epsilon^k \to 1$.

and the child utility u^k we define

$$\alpha_i^{0,k*}(w_i, p_a) = \alpha_i^{0,k} + \alpha_i^{i,k} \ln(w_i/p_a) \qquad \text{for } i = 1, 2, \tag{4.9}$$

and impose the following constraints

$$\alpha_i^{0,k*}(w_i^{min}, p_a) < 0 \tag{4.10a}$$
$$\alpha_i^{0,k*}(w_i^{max}, p_a) < 0. \tag{4.10b}$$

where w_i^{min} and w_i^{max} are the minimum and maximum potential net labor income observed in the data. The constraints ensure that $-\alpha_i^{0,k*}(w_i, p_a)$, the derivative of parental utility w.r.t. child utility, is positive for any observed potential net labor income. We impose similar constraints on $\alpha_i^{0,p*}(w_i, p_a)$ to ensure that there is an increasing relation between parental utility and the domestic good. In total there are 20 non-linear restrictions, the 8 lower bounds and 8 upper bounds on the substitution elasticities of child utility and the domestic good in equations (4.5a)-(4.5d) and the 4 non-negativity restrictions on the derivative of parental utility with respect to child utility and the domestic good in equations (4.10a) and (4.10b).

In terms of model mechanics child utility and the domestic good have two roles. First, child utility and the domestic good shift relative preferences for private consumption versus leisure. This mechanic introduces additional heterogeneity in terms of the consumption-leisure preferences, allowing production shifters, such as the number of children and their mean age, to affect the consumption-leisure trade-off. Second, an increase in child utility increases parental utility directly. The second mechanism is meant to reflect the idea that parents care about their children's welfare. In this specification the child's welfare is simply incorporated into the parent's utility function. While all households have an incentive to produce the domestic good, households with two adults have a stronger incentive than single adults since the domestic good is a pure public good. Economies of scale arise for two adult households with respect to single adult households due to the formers' ability to enjoy non-rival use of the domestic good. Similarly, two-parent households enjoy economies of scale with respect to single parents due to shared enjoyment of their children's welfare.

4.2.1 Model solutions

The model solutions are partially the same as in Cherchye, de Rock, and Vermeulen (2012b). Since there are minor specification differences we reproduce some of their results here. Throughout this section we suppress dependence of functions on the explanatory variables $\mathbf{d_i}$, $\mathbf{s}$ and $\mathbf{z}$.

The household problem can be seen as a two stage budgeting problem. We define $\rho_i = w_i + x_i$ as the excess of individual full expenditure over potential labor income.[5] Substituting $x_i = w_i + \rho_i$ into equation (4.11) and (4.2), we can represent the first stage problem as

$$\begin{aligned}\max_{\rho_1,\rho_2,u^p,u^k} \mathcal{L} = & \Lambda_1 v_1(w_1+\rho_1, w_1, p_a; u^p, u^k) \\ & +\Lambda_2 v_2(w_2+\rho_2, w_2, p_a; u^p, u^k) \\ & +\mu(y-\rho_1-\rho_2-G^k u^k - G^p u^p).\end{aligned}$$

The first order conditions for this problem are

$$\begin{aligned}
\frac{\partial \mathcal{L}}{\partial \rho_i} &= \frac{\Lambda_i}{(w_i/p_a)^{\beta_i}}\frac{1}{w_i+\rho_i} - \mu = 0 \\
\to \rho_i &= \frac{1}{\mu}\frac{\Lambda_i}{(w_i/p_a)^{\beta_i}} - w_i \\
\frac{\partial \mathcal{L}}{\partial u^k} &= -\frac{\Lambda_1}{(w_1/p_a)^{\beta_1}}\frac{\alpha_1^{k*}(w_1/p_a)}{u^k} - \frac{\Lambda_2}{(w_2/p_a)^{\beta_2}}\frac{\alpha_2^{k*}(w_2/p_a)}{u^k} - \mu G^k = 0 \\
\to G^k u^k &= \frac{1}{\mu}\left[-\frac{\Lambda_1}{(w_1/p_a)^{\beta_1}}\alpha_1^{k*}(w_1/p_a) - \frac{\Lambda_2}{(w_2/p_a)^{\beta_2}}\alpha_2^{k*}(w_2/p_a)\right] \\
\frac{\partial \mathcal{L}}{\partial u^p} &= -\frac{\Lambda_1}{(w_1/p_a)^{\beta_1}}\frac{\alpha_1^{p*}(w_1/p_a)}{u^p} - \frac{\Lambda_2}{(w_2/p_a)^{\beta_2}}\frac{\alpha_2^{p*}(w_2/p_a)}{u^p} - \mu G^p = 0 \\
\to G^p u^p &= \frac{1}{\mu}\left[-\frac{\Lambda_1}{(w_1/p_a)^{\beta_1}}\alpha_1^{p*}(w_1/p_a) - \frac{\Lambda_2}{(w_2/p_a)^{\beta_2}}\alpha_2^{p*}(w_2/p_a)\right] \\
\frac{\partial \mathcal{L}}{\partial \mu} &= y - \rho_1 - \rho_2 - G^k u^k - G^p u^p \\
\to \frac{1}{\mu} &= \frac{x}{X},
\end{aligned}$$

where $x = w_1 + w_2 + y$ is full expenditure, $\alpha_i^{p*}(w_i, p_a)$ is defined analogous

[5] In practice individual full expenditure tends to be lower than potential labor income. In this case non-private expenditures are financed by labor income.

to $\alpha_i^{k*}(w_i, p_a)$ in equation (4.9) and

$$\begin{aligned} X = &\frac{\Lambda_1}{(w_1/p_a)^{\beta_1}}(1 - \alpha_1^{k*}(w_i, p_a) - \alpha_1^{p*}(w_i, p_a)) \\ &+ \frac{\Lambda_2}{(w_2/p_a)^{\beta_2}}(1 - \alpha_2^{k*}(w_i, p_a) - \alpha_2^{p*}(w_i, p_a)) \end{aligned}$$

Substituting $\frac{1}{\mu}$ into the first order conditions and rearranging gives

$$\rho_i = \frac{x}{X}\frac{\Lambda_i}{(w_i/p_a)^{\beta_i}} - w_i \tag{4.11a}$$

$$u^k = \frac{x}{X}\frac{1}{G^k}\left[-\frac{\Lambda_1}{(w_1/p_a)^{\beta_1}}\alpha_1^{k*}(w_1/p_a) - \frac{\Lambda_2}{(w_2/p_a)^{\beta_2}}\alpha_2^{k*}(w_2/p_a)\right] \tag{4.11b}$$

$$u^p = \frac{x}{X}\frac{1}{G^p}\left[-\frac{\Lambda_1}{(w_1/p_a)^{\beta_1}}\alpha_1^{p*}(w_1/p_a) - \frac{\Lambda_2}{(w_2/p_a)^{\beta_2}}\alpha_2^{p*}(w_2/p_a)\right]. \tag{4.11c}$$

Furthermore, by minimizing the cost of producing u^k w.r.t. h_1^k, h_2^k and c^k and minimizing the cost of producing u^p w.r.t. h_1^p, h_2^p and c^p we find

$$h_1^k = n \cdot \frac{u^k}{G^k(w_1, w_2)^{\epsilon^k - 1}}\left(\frac{w_1}{\gamma_1^k}\right)^{\frac{1}{\epsilon^k}} \tag{4.12a}$$

$$h_2^k = n \cdot \frac{u^k}{G^k(w_1, w_2)^{\epsilon^k - 1}}\left(\frac{w_2}{\gamma_2^k}\right)^{\frac{1}{\epsilon^k}} \tag{4.12b}$$

$$c^k = n \cdot \frac{u^k}{G^k(w_1, w_2)^{\epsilon^k - 1}}\left(\frac{p_a}{\gamma_3^k}\right)^{\frac{1}{\epsilon^k}} \tag{4.12c}$$

$$h_1^p = \frac{u^p}{G^p(w_1, w_2)^{\epsilon^p - 1}}\left(\frac{w_1}{\gamma_1^p}\right)^{\frac{1}{\epsilon^p}} \tag{4.12d}$$

$$h_2^p = \frac{u^p}{G^p(w_1, w_2)^{\epsilon^p - 1}}\left(\frac{w_2}{\gamma_2^p}\right)^{\frac{1}{\epsilon^p}} \tag{4.12e}$$

$$c^p = \frac{u^p}{G^p(w_1, w_2)^{\epsilon^p - 1}}\left(\frac{p_{na}}{\gamma_3^p}\right)^{\frac{1}{\epsilon^p}}, \tag{4.12f}$$

with associated unit costs

$$G^p = \left[\gamma_1^{p\,\frac{-1}{\epsilon^p - 1}} w_1^{\frac{\epsilon^p}{\epsilon^p - 1}} + \gamma_2^{p\,\frac{-1}{\epsilon^p - 1}} w_2^{\frac{\epsilon^p}{\epsilon^p - 1}} + \gamma_3^{p\,\frac{-1}{\epsilon^p - 1}} p_{na}^{\frac{\epsilon^p}{\epsilon^p - 1}}\right]^{\frac{\epsilon^p - 1}{\epsilon^p}} \tag{4.13}$$

$$G^k = \left[\gamma_1^{k \frac{-1}{\epsilon^k - 1}} w_1^{\frac{\epsilon^k}{\epsilon^k - 1}} + \gamma_2^{k \frac{-1}{\epsilon^k - 1}} w_2^{\frac{\epsilon^k}{\epsilon^k - 1}} + \gamma_3^{k \frac{-1}{\epsilon^k - 1}} p_a^{\frac{\epsilon^k}{\epsilon^k - 1}} \right]^{\frac{\epsilon^k - 1}{\epsilon^k}}. \tag{4.14}$$

In the second stage each partner maximizes their individual utility function $v_i = u_i(c_i, l_i, u^k, u^p)$ w.r.t. c_i and l_i conditional on the first stage outcomes h_i^k, h_i^p, ρ_i, u^k, u^p and subject to

$$p_a c_i + w_i l_i = \rho_i + w_i \tag{4.15a}$$

$$m_i + l_i + h_i^k + h_i^p = 1 \quad \text{for } i = 1, 2. \tag{4.15b}$$

where m_i is the share of time spent on market work.

In practice we apply Roy's identity to the individual indirect utility functions $v_i(x_i, w_i, p_a; u^p, u^k, \mathbf{d_i})$ to find the optimal levels of private consumption and leisure

$$l_i = \left[\alpha_i^1 + \alpha_i^{0,k} \ln u^k + \alpha_i^{0,p} \ln u^p + \beta^i \ln \left(\frac{w_i + \rho_i}{\alpha_i(w_i, p_a; u^p, u^k)} \right) \right] \frac{w_i + \rho_i}{w_i} \tag{4.16a}$$

$$c_i = \left[1 - \alpha_i^1 - \alpha_i^{0,k} \ln u^k - \alpha_i^{0,p} \ln u^p - \beta^i \ln \left(\frac{w_i + \rho_i}{\alpha_i(w_i, p_a; u^p, u^k)} \right) \right] \frac{w_i + \rho_i}{p_a}. \tag{4.16b}$$

The demand equations above apply directly to two-parent households. For households without children the system simplifies by setting $\alpha_i^{0,k} = 0$ and $\alpha_i^{i,k} = 0$ so that child utility drops out of the utility function of adult members. For single men we set $\Lambda = 1$ and for single women(/mothers) we set $\Lambda = 0$ so that the partner's utility function drops out of the household objective function. For identification purposes, we assume that the production function parameters and the preference parameters $\alpha_i^{0,k}$, $\alpha_i^{0,p}$, $\alpha_i^{i,k}$ and $\alpha_i^{i,p}$ are the same across household types. All other preference parameters and sharing rule parameters are household type specific. The estimation method and results are discussed in Appendix 4.A.1.

4.2.2 Singles Equivalent Full Individual Consumption

In this section we derive the equation for Singles Equivalent Full Individual Consumption (SEFIC) and the equation for indifference scales in the spirit of Browning, Chiappori, and Lewbel (2013). We keep our definition of SEFIC as close as possible to the Browning, Chiappori, and Lewbel (2013) definition of equivalent expenditure. SEFIC is defined as the full expenditure level $C_{i,j}$ required by an individual household member i purchasing goods privately and engaging in household production alone, to be as well off materially as he or she is living with others in a household that has household full expenditure level x. By assumption household full expenditure x equals household potential income plus dissaving $w_1 + w_2 + y$. Note the difference between $C_{i,j}$ and $x_{i,j}$. The former is the level of household full expenditure on all goods an individual needs as a single person while the latter is that same individual's level of individual full expenditure on leisure and consumption in their true household type. To relate it to Cherchye, de Rock, and Vermeulen (2012b), we define indifference scales and SEFIC for men as follows

$$\begin{aligned} IS_{1,j} &= C_{1,j}/(w_1 + w_2 + y) \\ C_{1,j} &= \min_{c_1^*, c^{p*}, l_1^*, h_1^{p*}} p_a c_1^* + p_{na} c^{p*} + w_1(l_1^* + h_1^{p*}) \qquad \text{s.t.} \\ & u_{1,s}(c_1^*, l_1^*, u_s^p(c^{p*}, h_1^{p*}, 0), 0) = u_{1,j}(c_1, l_1, u_j^p(c^p, h_1^p, h_2^p), u_j^k(c^k, h_1^k, h_2^k)) \end{aligned} \tag{4.17}$$

and analogously for women, where $u_{1,j}$ is the direct utility function corresponding to $v_{1,j}$ the indirect utility function for a man in household type j. The function $v_{1,s}$ reflects indirect utility as a single man. We do not intend to make an interpersonal utility comparison. Below we therefore equate all the parameters of $v_{1,s}$ and $v_{1,j}$. This ensures we are comparing the same person in two household types using the same preference set. The domestic good input h_2^p is set to zero in $v_{1,s}$ since the man no longer has a spouse. The child utility u_s^k has also been set to zero because it is not available to childless households. Note that we do not consider what happens to the children when one of the parents becomes a single person living alone. While interesting, this question is outside the scope of this paper and has already been addressed by Cherchye, de Rock, and Vermeulen (2012b). Equation (4.17) is easy to understand: We require that a member of a household of type j attains the same level of utility obtained in the couple when they live as a single person at minimum cost. This means that as a single person they optimally choose $c_1^*, c^{p*}, l_1^*, h_1^{p*}$. Since $x_1 = w_1 + \rho_1^* = p_a c^* + w_1 l_1^*$ and $u_s^{p*}(c^{p*}, h_1^{p*}, 0)$, (4.17) is equivalent to

$$\begin{aligned} IS_{1,j} &= C_{1,j}/(w_1 + w_2 + y) \\ C_{1,j} &= \min_{\rho_1^*, u_s^{p*}} \rho_1^* + G_s^p u_s^{p*} \qquad \text{s.t.} \\ & v_{1,s}(w_1 + \rho_1^*, w_1, p_a; u_s^{p*}, 0) = v_{1,j}(w_1 + \rho_1, w_1, p_a; u_j^p, u_j^k), \end{aligned} \tag{4.18}$$

where u_s^{p*} and G_s^p are respectively the optimal level and unit cost of the domestic good when single. The derivation starts from

$$v_{i,s}(x_{i,s}(C_{i,j}), w_i, p_a; u_s^p(C_{i,j}), 0) = v_{i,j}(x_{i,j}, w_i, p_a; u_j^p, u_j^k) \tag{4.19}$$

where $C_{i,j}$ denotes singles equivalent consumption of adult $i = 1, 2$ currently living in a household of type j, $x_{i,j}$ is actual individual consumption expenditure in household type j and $x_{i,s}$ is full expenditure on leisure and private goods as a single person. All variables with subscript j are predictions for the individual's true household type. These are therefore simply the predictions that roll out of the model when we substitute the parameter estimates found in Appendix 4.A.2 into the outcome equations presented in Section 4.2.1. Corresponding to the predicted outcome for an individual's true household type we can find their predicted utility level $v_{i,j}$. Variables with subscript s can be predicted under the counterfactual that individual i lives alone but retains his/her potential labor income and background variables. The problem here is to solve equation (4.19) for the level of (household) full expenditure $C_{i,j}$ that one needs as a single person to set utility as a single person equal to $v_{i,j}$.

The single person's optimization problem is a simplified version of the problem of a two-parent household. We find the single persons indirect utility function by setting $\Lambda = 0$ in equation (4.11) and $\alpha_i^{0,k} = 0$ and $\alpha_i^{i,k} = 0$ in equation (4.8a). The single person's allocation problem then simplifies to maximizing

$$v_{i,s} = \frac{\ln(w_i + \rho_i) - \ln a_i(w_i, p_a; u_s^p)}{(w_i/p_a)^{\beta_i}},$$

where

$$\begin{aligned}\ln a_i(w_i, p_a; \bar{u}_s^p) = {} & \left[\alpha_i^0 + \alpha_i^{0,p} \ln u^p\right] + \ln p_a \\ & + \left[\alpha_i^i(\mathbf{d_i}) + \alpha_i^{i,p} \ln u^p\right] \ln \frac{w_i}{p_a},\end{aligned}$$

with respect to ρ_i and u_s^p, subject to

$$\rho_i + G_s^p u_s^p = y_{i,j}.$$

where ρ_i is still residual non-labor income after paying for household production. If $C_{i,j}$ represents the level of full consumption expenditure required to achieve indifference with living in a two-parent household (SEFIC), then $y_{i,j}$ is the corresponding level of non-labor income plus dissaving. Using this definition we write the Lagrangian for this problem as

$$\mathcal{L}_{i,s} = v_{i,s} + \mu(C_{i,j} - w_i - \rho_i - G^p_s u^p_s).$$

We solve this optimization problem and derive the expression for SEFIC in Appendix 4.B. There we find that SEFIC is given by

$$\begin{aligned} C_{i,j} = {} & x_{i,j}^{\frac{(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}}}{1-\alpha^{p*}_{i,s}}} \\ & \cdot\ e^{\frac{\alpha^{0,0}_{i,s}-\alpha^{0,0}_{i,j}(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}}}{1-\alpha^{p*}_{i,s}}} \\ & \cdot\ w_i^{\frac{\alpha^{i,0}_{i,s}-\alpha^{i,0}_{i,j}(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}}}{1-\alpha^{p*}_{i,s}}} \\ & \cdot\ p_a^{\frac{(1-\alpha^{i,0}_{i,s})-(1-\alpha^{i,0}_{i,j})(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}}}{1-\alpha^{p*}_{i,s}}} \\ & \cdot\ {u^p_j}^{\frac{-\alpha^{p*}_{i,j}(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}}}{1-\alpha^{p*}_{i,s}}} \\ & \cdot\ {u^k_j}^{\frac{-\alpha^{k*}_{i,j}(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}}}{1-\alpha^{p*}_{i,s}}} \\ & \cdot\ \left(1-\alpha^{p*}_{i,s}\right)\left(\frac{-\alpha^{p*}_{i,s}}{G^p_s}\right)^{\frac{\alpha^{p*}_{i,s}}{1-\alpha^{p*}_{i,s}}}, \end{aligned} \tag{4.20}$$

where we suppress dependence of functions on wages, prices, taste shifters, production shifters and distribution factors to improve readability.

Indifference scales are equal to SEFIC over the household's full expenditure level

$$IS_{i,j} = \frac{C_{i,j}}{x}. \tag{4.21}$$

For members of couples without children $\alpha^{k*}_{i,j} = 0$ and the factor on the second to last line of equation 4.20 equals 1.

The derivative of $C_{i,j}$ with respect to the level of the domestic good consumed in the current household u_j^p is given by

$$\frac{\partial C_{i,j}}{\partial u_j^p} = \frac{-\alpha_{i,j}^{p*}(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}}}{1-\alpha_{i,s}^{p*}} \frac{C_{i,j}}{u_j^p}.$$

This derivative is positive since we require $\alpha_{i,j}^{p*} < 0$. Intuitively this make sense, consuming a higher level of the public good in the true household type increases welfare and thus increase the level of full expenditure required to be indifferent with living alone. A similar result applies to the derivative with respect to child utility.

The bargaining weights Λ_1, Λ_2 affect SEFIC through individual consumption $x_{i,j}$, child utility u_j^k and the domestic good u_j^p in household type j. In Appendix 4.B we substitute the solutions for $x_{i,j}$, u_j^k and u_j^p into equation (4.20) and find SEFIC as a function of the bargaining weights.

4.3 Data

4.3.1 LISS panel

This paper makes use of various parts of the Longitudinal Internet Studies for the Social Sciences (LISS) panel administered by CentERdata (Tilburg University, the Netherlands). The LISS panel is a representative sample of Dutch individuals who participate in monthly Internet surveys. The panel is based on a true probability sample of households drawn from the population register. Households that could not otherwise participate are provided with a computer and Internet connection. A longitudinal survey is fielded in the panel every year, covering a large variety of domains including work, education, income, housing, time use, political views, values and personality.

We use expenditure and time allocation data from the 2009, 2010 and 2012 waves of the Time Use and Consumption module (TUC hereafter). The TUC module was fielded in September of 2009 and 2010, October of 2012, March of 2015 and July of 2017. This data is merged with labor income and background data for the corresponding month, and data about children, non-labor income and work hours for the corresponding year. The TUC module was originally used in Cherchye, de Rock, and Vermeulen (2012b). We extend the two-parent model of Cherchye, de Rock, and Vermeulen (2012b) to cover single persons, childless couples, single mothers and two-parent households.

A few minor differences in terms of the preference specification, production function specification and variable definition are discussed throughout the paper.

We focus on the same set of outcome variables as the aforementioned study. Respondents of the TUC module are asked to report, as best they can recall, their time expenditure over the past week on paid work, commuting, leisure and a number of domestic work activities. Referring to the time budget in (4.15b) we construct the variable market work (m_i) as hours of paid work plus commuting time, domestic work (h_i^p) as household chores and administrative chores, parental child care (h_i^k) as activities with children, and leisure time (l_i) as all other activities including sleeping and resting. All expenditure categories are based on TUC questions that ask the respondent to recall average monthly expenditure (over the last 12 months) on a category of goods. Respondents are asked for their personal consumption expenditure for 10 separate goods categories, such as food, clothing and personal care. These are summed up and then divided by the price index for assignable goods p_a to construct individual expenditure c_i in equation (4.15a). Real child expenditure c^k from equation (4.12c) is the sum of a number of categories that are the child equivalent to the personal consumption categories for parents. To these expenditures we add daycare expenditures net of subsidy and then divide by the price index p_a.[6] Public expenditure c^p from equation (4.12f) is the sum of expenditure on all non-assignable goods excluding day care expenditure (e.g. housing, utilities and insurance) divided by a price index for non-assignable goods. The aforementioned price indices are constructed based on prices and basket weights as reported by Statistics Netherlands. These price indices are normalized to one in 2015.

To determine potential labor income we use an alternative version of hours worked and commuted.[7] The core modules of LISS contains questions about hours worked and hours of commuting time per week. We add these two up to find the alternative market work time variable. We divide net monthly labor income by hours worked and commuted and multiply by 168

[6] Child care is subsidized for all households, but quite heavily for low income households. For a treatment of this subject see Chapter 3 of this dissertation. The subsidy schedule used here is presented in Section 3.3

[7] Potential labor income is found by dividing net labor income by the share of work and commuting in total time. If we use the same measure of hours worked and commuted as a dependent variable, then using potential income as an explanatory variable introduces division bias. Hence we use an alternative.

to obtain potential net monthly labor income per month. The LISS survey does not ask respondents for their partner's net monthly labor income or hours worked. We therefore limit the sample to households in which both partners took part in the survey.

The variable y in equation (4.2) measures the sum of (monthly) non-labor income and net dissaving. We construct this variable by subtracting household potential labor income $w_1 + w_2$ from household full expenditure x. This is equivalent to subtracting household labor income from expenditure on market goods. We construct a separate measure of non-labor by adding up several sources of non-labor income found in the core modules. This measure of non-labor income is used as a distribution factor, in the sense that it only affects the bargaining weights.

Aside from the aforementioned variables we use each partner's age and education, the civil status of a couple, the number of children in the household and the mean age of children living at home as additional explanatory variables. Education is a dummy equal to 1 when the respondent has completed a degree in the Dutch higher education system (at the higher vocational education or university level). We construct a marriage dummy equal to 1 if a couple is married. Parents are asked to state the birth year of all children living at home. From this data we construct the number of children living at home as well the mean age of children living at home. Furthermore, we construct the age difference between partners and relative potential net labor income. The latter is defined as the man's potential net labor income over both partners' potential net labor income.

The dataset discussed above covers the years 2009, 2010, 2012, 2015 and 2017. However, we can only use the years 2009, 2010 and 2012 to estimate the model of Section 4.2. The 2015 and 2017 waves of TUC no longer contain the full set of expenditure and time use categories present in the earlier waves. In contrast to waves, the 2015 and 2017 waves do not record disaggregate individual expenditure (on e.g. food and clothing). For the purpose of the present analysis this change is not problematic as only aggregate individual expenditures (c_i) are considered. However, we also no longer observe how much time is spent on household chores, administrative chores as well as the majority of time uses which we categorize as leisure. Consequently the variables domestic work (h_i^p) and leisure time (l_i) cannot be constructed for 2015 and 2017. The variables market work (m_i) and parental child care (h_i^k) can still be constructed without problems. We are thus missing one piece of information per individual in the 2015 and 2017 waves. We do not observe how time not used for paid work or child care is divided between domestic work and leisure. Data from the 2015 and 2017 waves are therefore not used to estimate the model.

We construct time series for SEFIC inequality as well as inequality in expenditure and time use categories for the full set of waves. The missing values of domestic work and leisure time in 2015 and 2017 are simulated using the model of Section 4.2. The details of this simulation approach as well as the approach to constructing inequality series are discussed in Section 4.4.

4.3.2 Sample selection

We narrow the full sample down to a base sample consisting of households with a single member, a single parent with children or an opposite sex couple with or without children. All households with members other than those listed above are deleted. All children living at home must be younger than 18. This selection criterion is intended to rule out that children have substantial income, and have influence on the household's expenditure and time use. All adult household members must be younger than 65 as we are focusing on the employed working age population. We require that the adult members of the households in the base sample completed the TUC module. We then construct an estimation sample and a simulation sample by applying the selection criteria listed in Table 4.1 in order. There are two differences between the two samples. First, the estimation sample covers the years 2009, 2010 and 2012 whereas the simulation sample extends to the years 2015 and 2017. Second, the estimation sample does not include single-earner couples whereas the simulation sample does. Specifically, in the estimation sample we require that any adult member works 10 or more hours. In the simulation sample we only require that one adult member per household works 10 or more hours.[8] In Section 4.4 we discuss our approach to estimating a reser-

[8]The loss of observations from the 10 hours worked criterion is larger than one might expect based on macro-economic statistics. The LISS survey asks respondents for their hours worked in the previous week. The share of the sample that works less than 10 hours in any given week is naturally higher than the share that works less than 10 hours a week on average. Aside from the possibility that some respondents simply have work weeks of variable length, the difference can also be explained by respondents being on vacation or leave.

vation wage for adult household members who do not work. The following sample selection criteria apply to both the estimation and simulation sample. We exclude student households. We drop households if the potential monthly labor income of either adult member is missing or the birth years of children are missing provided that this data cannot be imputed from other waves. We exclude some households with unrealistic expenditure. E.g. those who spend far in excess of their income. We also exclude households with unrealistic monthly labor income data. E.g. individuals with monthly potential labor income below €500 a month are dropped from the sample because this is far less than is consistent with the Dutch minimum wage. The sample of single fathers becomes too small to analyze therefore we exclude these households from both the estimation and simulation sample. To maintain comparability between men and women we do not include single mothers when calculating inequality series. We do construct SEFIC levels for single mothers. The observations in the final sample(s) are about equally split between the years.

The LISS panel's pool of respondents is representative of the general population of the Netherlands. We construct population weights, to reweigh the LISS sample to our population of interest, which is the population of employed working age (18-65 year old) individuals rather than the general population. Reweighing would have been necessary regardless, as uptake of the various surveys and completion of the surveys, either partially or completely, is likely non-random. The population weights for our sample are based on the distribution of age, education and household type as reported by Statistics Netherlands for the population of households with employed adult members aged 18-65 and children living at home younger than 18.[9]

[9] Households are classified by type as either a single adult or couple of adults, by marital status and by the number of children. The weights are based on three frequency tables published by Statistics Netherlands. The first table reports the number of households with children by household type, number of children and age group of children. The second table reports the number of households by whether there is a single adult member or a couple, by marital status, the number of children (regardless of their age) and age of the household head. We use the frequencies from the former table for household with children younger than 18 and the frequencies from the latter table for other households with reference persons aged 18 and 65. We need to assume that the distribution by household type, number of children and age group of children is the same for reference persons aged 18 and 65 as for the entire population. This gives us the marginal distribution for household type. The third table reports the joint age and education distribution which we use to construct a marginal distribution for education (as defined above) and 3 age categories. The joint distribution of household type, education and age is not reported by Statistics Netherlands. We apply the RAS method to construct a joint distribution of

Table 4.1: Sample selection

(a) Estimation sample, 2009-2012

Adults	Single	Couple	Couple	Single	Total
Children	No	No	Yes	Yes	
Base sample[a]	1869	1021	725	176	3791
Adults work < 10 hours	1192	443	489	137	2261
Pot. labor income missing[b]	1187	443	489	137	2256
Implausible expenditure/income	1140	424	475	136	2175
Single fathers	1140	424	475	101	2140

(b) Simulation sample, 2009-2017

Adults	Single	Couple	Couple	Single	Total
Children	No	No	Yes	Yes	
Base sample[a]	3453	1590	1138	311	6492
Adults work < 10 hours	2149	1228	1094	227	4698
Pot. labor income missing[b]	2140	1227	1091	227	4685
Implausible expenditure/income	2113	1210	1085	221	4629
Single fathers	2113	1210	1085	162	4570

[a] All households are headed by a single person or couple with or without children, all children are younger than 18, all other members are younger than 65. [b] Missing after imputation from previous years.

Table 4.2: Descriptive statistics of the simulation sample - Outcome variables

Household type	Single person		Childless couple		Two parent		Single parent	
	Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.
Expenditure (€1000/month)								
Private expenditure men[a]	0.35	0.56	0.42	0.54	0.39	0.44	-	-
Private expenditure women[a]	0.35	0.46	0.46	0.49	0.36	0.33	0.40	0.44
Public expenditure	1.30	1.20	1.62	0.89	1.85	1.49	1.44	1.06
Child expenditure	-	-	-	-	0.59	1.24	0.27	0.23
Time use, hours/week[b]								
Child care husband	-	-	-	-	12.03	9.54	-	-
Domestic work husband[a]	11.16	7.86	11.89	10.57	11.22	8.50	-	-
Market work husband[a]	46.59	13.88	41.68	19.44	46.47	15.34	-	-
Leisure husband[a]	110.26	14.83	114.42	18.03	98.28	16.88	-	-
Child care wife[a]	-	-	-	-	21.64	16.33	12.38	4.25
Domestic work wife[a]	13.22	9.74	19.71	14.48	22.43	14.36	14.58	5.33
Market work wife[a]	39.83	13.47	27.87	19.14	22.09	15.71	32.59	8.23
Leisure wife[a]	114.95	14.31	120.42	18.93	101.86	18.48	108.46	30.64
Observations	2113		1210		1085		162	

[a] For singles the mean is taken over men and women separately. [b] The mean is taken over the years 2009-2012 (the estimation sample) as leisure and domestic work hours are not observed in 2015 and 2017.

Table 4.3: Descriptive statistics of the simulation sample - Explanatory variables

Household type	Single person		Childless couple		Two parent		Single parent	
	Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.
Income (€1000/month)								
Potential net labor income men[a]	7.80	3.51	8.23	3.46	8.04	2.57	-	-
Potential net labor income women[a]	8.25	4.04	7.59	2.75	7.81	3.00	8.06	3.45
Non-labor income	-0.32	1.65	-0.63	1.82	0.03	2.59	0.47	1.61
HH expenditure-HH labor income	0.05	0.18	0.11	0.37	0.09	0.30	0.18	0.44
Age men[a]	39.36	11.18	44.08	12.22	41.77	6.38	-	-
Age women[a]	39.00	12.70	43.25	12.46	39.43	6.36	42.53	6.46
Education men[ab]	0.29	0.49	0.32	0.48	0.37	0.49	-	-
Education women[ab]	0.41	0.50	0.30	0.46	0.34	0.48	0.33	0.50
Rel. pot. labor income $w_1/(w_1+w_2)$	-	-	0.53	0.30	0.57	0.26	-	-
Married dummy	-	-	0.63	0.43	0.77	0.40	-	-
Age difference women-men	-	-	-2.21	4.12	-2.18	3.71	-	-
Nr. children (at home)	-	-	-	-	1.90	0.79	1.43	0.66
Nr. children (at home) age 0 to 4	-	-	-	-	0.49	0.68	0.10	0.30
Nr. children (at home) age 5 to 12	-	-	-	-	0.91	0.93	0.72	0.77
Mean age of children (at home)	-	-	-	-	0.84	0.46	1.14	0.40
Observations	2113		1210		1085		162	

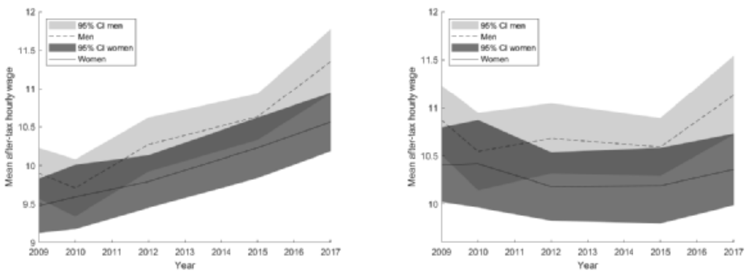
[a] For singles the mean is taken over men and women separately.[b] Education is a dummy equal to 1 if the respondent completed a degree in the Dutch higher education system (HBO/WO).

Table 4.2 reports the mean and standard deviation of all outcome variables over the pooled 2009-2017 waves, with the exception of domestic work and leisure hours which are averaged over the 2009-2012 waves. Table 4.3 reports the mean and standard deviation of all explanatory variables over the pooled 2009-2017 waves. The mean values of age, education and marriage rates in the weighted simulation data match the (Statistics Netherlands) population means by construction. By comparing the weighted to the unweighted means we find that data over-samples the old, the high educated, singles and single parents. The difference between household expenditure and household labor income equals non-labor income minus saving. By subtracting this level from non-labor income we thus get the level of saving. We find that single persons save on average €370 a month, childless couples save €740 a month, two parent households save €60 a month and single mothers on average dissave by €290 a month. In the 2015 sample working single men have mean potential monthly net labor income of €7.610 which is consistent with earning €1940 after-tax per month given their actual work hours. This is quite close to the mean after tax income of €1875 reported by Statistics Netherlands (2016, disposable income for employed single person households).

Figure 4.1: Mean after-tax hourly wage by gender

(a) Nominal wage

(b) Real wage at 2015 prices



Source: Own calculations based on LISS core modules and Statistics Netherlands price indices.

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household type, education and age for the population based on the distribution observed in the LISS core modules sample. We use the iterative approach proposed in Bacharach (1970) to achieve convergence.

Nominal labor income has not remained constant over the 2009 and 2017 period. Figure 4.1(a) illustrates this point by plotting the development of the geometric mean after-tax nominal hourly wage and its confidence interval by gender based on labor supply data from the LISS core modules. Nominal labor incomes increased significantly between 2009 and 2017. However, real incomes have not changed significantly in the aftermath of the financial crisis. Figure 4.1(b) suggests that the sample experienced a period of weakly negative growth real wage growth between 2009 and 2015 and weakly positive real wage growth between 2015 and 2017.

4.4 Methodology

The goal of this paper is to analyze inequality in individual consumption, operationalized as Singles Equivalent Full Individual Consumption (SEFIC), inequality in disaggregate consumption expenditure, and inequality in time use categories. The main measure of inequality will be the variance of the logarithm of these variables. In case of SEFIC we also focus on other aspects of the distribution by constructing the Gini coefficient and 80/20 ratio.

The approach to constructing series for individual consumption c_i, public consumption c^p, child expenditure c^k, paid work hours m_i and parental child care hours h_i^k is straightforward. All these outcome variables are observed directly for each household member, in each wave of the data. Hence, we only need to calculate the inequality measure and its standard error.

To construct the remaining inequality series we need to estimate the model of Section 4.2. Appendix 4.A.1 describes the estimation methods and Appendix 4.A.2 presents the estimation results. We use the fitted model consisting of the equations for time use, private goods, public goods and child goods (see equations (4.11), (4.12), (4.16)) to predict outcome variables for all households in all waves of the data. The 2015 and 2017 predicted values of domestic work h_i^p and leisure l_i are necessary to construct inequality series for these variables. For all other outcome variables in 2015 and 2017 and all outcome variables in 2009-2012 we use the observed rather than the predicted values to construct inequality series.

The model can explain some of the variation in the outcome variables but not all of it. As a consequence the simulated 2015 and 2017 values of domestic work and leisure have lower variance than their observed counterparts in 2009-2012. If this issue is not addressed then the 2015 and 2017 measures of inequality will be too low. We address the problem by adding error terms to the simulated 2015 and 2017 values. We take the following approach. First, we calculate residuals for all outcome variables by taking the difference between the observed outcome values and the predicted outcome values from earlier.[10] Second, for each individual in the 2015 and 2017 wave we search for a match amongst individuals of the same gender and household type in the 2009-2012 waves. Third, we take the residuals for domestic work and leisure time from the matched individual and add these to the predicted values for domestic work and leisure time for the 2015/2017 individual. The matching approach is based on the smallest distance between the residuals for paid work and parental child care (if applicable) within the gender-household type group. For parents distance is measured as the sum of squares of the difference between the residuals for paid work and parental child care. For non-parents closeness if measured as the absolute difference between residuals for paid work.[11] The 2015 and 2017 values of domestic work and leisure we produce should have similar unexplained variation as the observed 2009-2012 values.

The estimated parameters are also needed to parameterize equation (4.20) for SEFIC, equation (4.4) for child welfare u^k, equation (4.3) for the domestic good u^p and equation (4.11a) for ρ_i. In order to find SEFIC we first plug the observed values of expenditure, time use and explanatory variables into equations (4.3), (4.4) and (4.11a), which yields values for u^k, u^p and ρ_i. Plugging u^k, u^p, ρ_i and the explanatory variables into equation (4.20) yields SEFIC. Indifference scales follow from equation (4.21). Finally, we calculate the SEFIC inequality measures reported in the next section.

The standard errors and confidence intervals reported for SEFIC inequality, domestic work and leisure time inequality for 2015 and 2017, and indifference scales were obtained by bootstrapping. Estimation of the model produced a vector of parameter estimates, which for convenience we will call $\hat{\beta}$, and a corresponding covariance matrix $\mathbf{V}_{\hat{\beta}}$. We draw 1.000 bootstrap parameter vectors $\tilde{\beta}_b$ for $b = 1, \ldots, 1.000$ from the multivariate normal distribution with mean $\hat{\beta}$ and covariance matrix $\mathbf{V}_{\hat{\beta}}$. For each $\tilde{\beta}_b$ we take the

[10] Naturally, this is not possible for domestic work and leisure in the 2015 and 2017 waves.

[11] In principle we could also match based on residuals for expenditure categories. The approach discussed here has the advantage that the produced values of domestic work and leisure and the observed values of paid work and child care add up to 1 approximately. Involving expenditure categories in matching would make this less likely.

following three steps. First, we predict all outcome variables for all waves using the drawn parameters vector. Second, we find residuals for the 2015 and 2017 values of domestic work and leisure using the matching approach discussed above. Third, we calculate SEFIC inequality and other measures. Once we complete these steps for $b = 1, \ldots, 1.000$ we calculate the bootstrapped standard errors and confidence intervals for SEFIC inequality and other measures.

A final methodological issue is the approach used to determine reservation wages for non-working partners in single-earner couples. The issue of rationing in collective labor supply models is discussed at length in Chapter 3. Here we suffice by saying that if a household decides not to work then the entire allocation of the household should be seen as demand under rationing. At the wage they could earn on the market the non-working partner has a latent demand for other time uses exceeding their time endowment, which can be seen as a natural ration on other time uses. According to rationing theory the demand for all goods in the household's demand system, including the demand for goods and time use by the partner, should then be evaluated at the reservation wage. The reservation wage is found by solving the rationing condition $m_1 = 0$ for non-working men or $m_2 = 0$ for non-working women in terms of the level of potential net labor income w_1^* and w_2^* respectively. These are the shadow potential net labor income levels, the levels of potential net labor income consistent with the reservation wage. In practice we use the model of Section 4.2 to determine w_1^* and w_2^*. We assume that the labor supply functions $m_1 = 1 - l_1 - h_1^k - h_1^p$ and $m_2 = 1 - l_2 - h_2^k - h_2^p$ from Section 4.2 reflect the latent labor supply by non-working partners. Note that the model is estimated based on a sample of singles, single parents and two-earner couples. The parameter estimates are not based on data for single-earner couples, but are assumed to apply to these household as well.[12] The estimated model can be used to generate m_1 for any value of w_1. We minimize the square of m_1 with respect to w_1 to find w_1^* and similarly for non-working women. The resulting value of w_1^* is used in place of potential net labor income w_1 to simulate SEFIC for single-earner couples. The main simulation results use a sample including single-earner couples. However, because our target population consist of employed individuals we calculate

[12]This assumption is a bit implausible. We would have preferred to estimate a model with rationing (an extended version of the model in of Chapter 3) on single-earner couples. However, we ran into computational difficulties.

inequality series only for the working individuals in these households. This means that the data of a non-working individual is only used to construct the outcome variables of their working partner. We present alternate results based on a sample that includes both members of single-earner couples and a sample that excludes members of single-earner couples altogether.

4.5 Simulation results

4.5.1 Mean results across household types

Following the approach described in Section 4.4 we use the model consisting of equations (4.11), (4.12), (4.16) to simulate outcome variables. Table 4.4 presents the simulated mean of each outcome variable for each household type. Men are predicted to work and commute on average 44 hours per week if they live alone, 45 hours per week if they live only with a partner and 46 hours per week if they have children. Women are predicted to work and commute for 38 hours a week if they are single, 34 hours if they have a partner but no children and 28 hours if they have both a partner and children. These mean simulated outcomes are in line with the mean observed outcomes in the simulation data. We predict that regardless of household type women do more household work than men. However, the differences are larger for couple members than for single persons. Women also spend more time taking care of children. Unless there are children in the household we predict that women have more leisure time than men. Note that the latter is broadly defined to include include such activities as schooling, helping others, sleeping and resting.

We now focus on the predicted bargaining weights ($\Lambda(\mathbf{z})$,$1-\Lambda(\mathbf{z})$) each member of a couple controls. We used equation (4.6) to simulate the bargaining weights of men in couples. We find that on average men in couples without children control 48% of expenditure and men in couples with children control 48% of expenditure with standard deviations of 2% and 3% respectively. The overall minimum of $\Lambda(\mathbf{z})$ and $1-\Lambda(\mathbf{z})$ are 36% and 42% respectively. There is little variation in the mean bargaining weight for men by household income quartile as it ranges between 47% and 50%, with standard errors between 2% and 3%. We cannot reject that any of these means differ from 50%. Expenditure shares produced in this paper are, compared to earlier findings in the literature, quite equally distributed. For example,

Table 4.4: Simulated outcome variables, 2009-2017 waves

	Men		Women	
Year	Mean	Std.Err.	Mean	Std.Err.
Singles				
Private expenditure	0.36	0.02	0.36	0.02
Public expenditure	1.42	0.05	1.27	0.03
Domestic work	11.71	0.27	14.20	0.35
Market work	44.92	0.42	39.04	0.47
Leisure	111.45	0.45	114.98	0.54
Couples without children				
Private expenditure	0.44	0.02	0.47	0.02
Public expenditure	1.73	0.02	1.73	0.03
Domestic work	11.94	0.25	19.24	0.29
Market work	45.07	0.50	34.05	0.57
Leisure	111.01	0.25	114.84	0.29
Couples with children				
Private expenditure	0.40	0.01	0.39	0.01
Child expenditure	0.61	0.03	0.56	0.04
Public expenditure	1.95	0.04	1.96	0.04
Child care	13.34	0.30	22.56	0.59
Domestic work	11.10	0.17	20.51	0.27
Market work	46.32	0.42	26.56	0.47
Leisure	97.51	0.20	98.75	0.25

Expenditure in €1000/month and otherwise in hours/week.

Browning, Chiappori, and Lewbel (2013) and Cherchye, de Rock, and Vermeulen (2012a) find a female bargaining weight of 63% and in Chapter 2 we find a female bargaining weight of 58%. The comparatively equal weights found here can be explained. The aforementioned studies tend to focus only on the allocation of expenditure to market goods. Expenditure on market goods is unequally distributed within households relative to full expenditure, which in our data on average consists for about 80% of the value of household work, child care and leisure time. The latter is relatively equally distributed amongst other reasons because a large part of it consists of time used for sleeping and resting.

Next, we focus on predictions of Singles Equivalent Full Individual Consumption (SEFIC). In Appendix 4.2.2 we derived equations (4.20) and (4.21), which are explicit closed form solutions for SEFIC and indifference scales (w.r.t. living alone) in the spirit of Browning, Chiappori, and Lewbel (2013). However, without further assumptions these equations imply interpersonal utility comparisons between single persons and members of the aforementioned household types. Instead we calculate SEFIC and indifference scales under the assumption that an individual's retains the preferences the have in their current household type when they live as a single person. E.g. for a two-parent household this implies that we impose $\alpha_{i,s}^{0,0} = \alpha_{i,tp}^{0,0}$, $\alpha_{i,s}^{i,0} = \alpha_{i,tp}^{i,0}$, $\alpha_{i,s}^{p*} = \alpha_{i,tp}^{p*}$, $\alpha_{i,s}^{k*} = \alpha_{i,tp}^{k*}$ and $\beta_{i,s} = \beta_{i,tp}$ on equation (4.20).

Table 4.5 reports the levels of SEFIC predicted according to equation (4.20) and indifference scales predicted according to equation (4.21). We report mean values of predicted indifference scales and SEFIC by equivalent household full expenditure quartiles for the pooled 2009-2017 waves.[13] Men in childless couples need 84% of their current household's expenditure level to be as well off as a single person as they are in their current household. Mechanically this is due to the fact men in couples have a partner who is relatively more "productive" in household work, which raises their enjoyment of the domestic good and increases their valuation of leisure and private expenditures considerably. Women in couples without children need 67% of their household's expenditure to be indifferent. Mothers with a partner need 42% of household expenditure to be indifferent with living alone. The 25 percentage point difference primarily reflects the burden of childcare to mothers. The comparable figure for fathers is 26 percentage points. [14] Compared to couples without children, parents need less compensation for moving to a single person household because they no longer face the costs of childcare. The cost of childcare also explains why a single mother's indifference scale is less than 1. Single mothers control all of their household's expenditure. Therefore an indifference scale of 62% implies that they need 38% less than their current full expenditure level to remain on their current indifference curve while living alone. This 38% reflects the burden of childcare to single mothers.

The indifference scales produced in this paper are not comparable to the

[13] Household full expenditure $w_1 + w_2 + y$ is divided by the OECD modified scale. We then take quartiles of the distribution of the pooled waves.

[14] The difference in indifference scales between couples with and without children also reflects income and demographic differences between these groups. By the number of children the figures for mothers are 21, 25 and 28 percentage points for 1,2 and 3 children respectively. For fathers these figures are 22, 26 and 30 percentage points.

Table 4.5: Simulated mean indifference scales by income quartile[a]

Household income quartile	1	2	3	4	Overall
Indifference scale - Men					
Childless couple	0.77	0.81	0.84	0.88	0.84
	0.63 - 0.89	0.68 - 0.93	0.69 - 0.92	0.76 - 1.02	0.72 - 0.95
Couple with children	0.56	0.58	0.60	0.61	0.58
	0.44 - 0.66	0.45 - 0.67	0.48 - 0.69	0.50 - 0.72	0.46 - 0.68
Indifference scale - Women					
Single mother	0.60	0.62	0.64	0.90	0.62
	0.39 - 0.72	0.41 - 0.73	0.45 - 0.74	0.62 - 1.11	0.42 - 0.75
Childless couple	0.57	0.65	0.69	0.69	0.67
	0.48 - 0.66	0.56 - 0.71	0.60 - 0.74	0.61 - 0.75	0.58 - 0.73
Couple with children	0.37	0.42	0.44	0.53	0.42
	0.24 - 0.44	0.29 - 0.51	0.30 - 0.53	0.37 - 0.63	0.29 - 0.51

Reported are the mean over the income quartile with a 95% confidence interval. [a] Indifference scales for a member of the specified household type and specified gender measures the share of their household's full expenditure needed to remain on the same indifference curve when living alone. Single fathers are excluded from the analysis because there are too few observations.

Table 4.6: Simulated mean SEFIC by income quartile[a]

Household income quartile	1	2	3	4	Overall
SEFIC - Men (€1000/month)[a]					
Single	5.14	6.81	8.35	12.57	7.45
	5.05 - 5.22	6.77 - 6.86	8.27 - 8.43	11.91 - 13.22	7.24 - 7.65
Childless couple	8.99	10.36	12.06	16.30	13.14
	7.23 - 10.20	8.62 - 11.87	10.00 - 13.37	14.08 - 18.60	11.23 - 14.83
Couple with children	7.13	8.74	10.25	12.87	9.17
	5.61 - 8.38	6.85 - 10.17	8.13 - 11.83	10.53 - 14.78	7.29 - 10.63
SEFIC - Women (€1000/month)[a]					
Single	5.19	6.87	8.41	13.62	7.96
	5.09 - 5.28	6.82 - 6.92	8.33 - 8.48	12.63 - 14.60	7.69 - 8.23
Single mother	4.06	5.53	7.05	13.28	5.14
	2.67 - 4.90	3.69 - 6.55	4.95 - 8.24	9.72 - 15.56	3.51 - 6.12
Childless couple	6.47	8.35	10.00	12.91	10.53
	5.28 - 7.31	7.08 - 9.04	8.70 - 10.83	11.42 - 14.04	9.24 - 11.49
Couple with children	4.69	6.37	7.50	11.20	6.79
	3.15 - 5.65	4.37 - 7.71	5.08 - 9.05	7.95 - 13.13	4.68 - 8.13

Reported are the mean over the income quartile with a 95% confidence interval. [a] Singles Equivalent Full Individual Consumption (SEFIC) for a member of the specified household type and specified gender measures the level of full expenditure needed to remain on the same indifference curve when living alone. Divide it by four to get a rough idea of what one would need to earn after-tax in a full-time job to support this level of spending. For childless single persons SEFIC equals full expenditure. Single fathers are excluded from the analysis because there are too few observations.

indifference scales produced in Cherchye, de Rock, and Vermeulen (2012b, p. 3400). Their indifference scales are based on keeping both a parent and the children indifferent between living in a two-parent household or a single-parent household (headed by the parent under consideration). The indifference scales for two-parent households presented here keep (only) the parent indifferent between living in a two-parent household and living alone.

Table 4.5 presents mean values of SEFIC by income quartile. For singles SEFIC equals a month's worth of expenditure on market goods plus non-market time. For other households types SEFIC equals the aforementioned value but inflated by a factor that increases with the partner's domestic work and child care hours. By assumption full expenditure equals potential labor income (plus non-labor income and dissaving), defined as the value of an entire month's worth of time. We can use this fact to make the SEFIC values a bit easier to interpret. A full time job takes up about 40 hours a week in the Netherlands plus commuting time. This is roughly a quarter of someone's time endowment. Therefore if we divide the SEFIC figures by 4 then we roughly get the after-tax income level that someone would need to earn in a full time job in order to afford the SEFIC level of expenditure (assuming they do not save or dissave).[15] For example, men in childless couples in the fourth household income quartile would need to earn about €4075 a month after taxes in a full time job to afford SEFIC. This is quite high considering that men in the fourth income quartile of singles actually earn about €3140 a month. The ratio between what couple members would need to earn as singles and what singles earn in the same quartile grows from 1.30 (16.30/12.57) in the fourth quartile to 1.75 (8.99/5.14) in the first quartile. There are two main takeaway from Table 4.5. First, as the example above illustrates economies of scale in couples are considerable. Second, economies of scale make an especially large difference in terms of SEFIC for lower income households. There are two reasons for the rather large differences in SEFIC between household types. First, household types differ in terms of age, education and income as the descriptive statistics in Table 4.3 confirm. The comparison above did not account for these differences. Second, there are strong economies of scale in couples arising from the shared consumption of the domestic good. The results suggest that members of couples, especially low income couples, who lose their partner suffer a large

[15] This explanation abstracts from the fact that in reality the average households saves a portion of labor income.

decline in economic welfare in addition to whatever broader welfare effects the change in household composition may have. We must be careful not to make a stronger claim. The model that generated the SEFIC values in Table 4.5 is identified with cross-sectional variation in outcomes for individuals in different household types, not variation in outcomes of individuals that switched household type.

Note that it is not possible to compare SEFIC for men with SEFIC for women without making further assumptions. Specifically, we would need to assume that preference parameters of single men and women are equal. This would imply that a single man and a single woman with the same level of spending (and covariates) are equally well off. Equivalence between genders for other household types then follows from the definition of SEFIC. However, this assumption is routinely rejected. Nevertheless we produce inequality series for the entire sample as well as the subsamples of men and women. The main justification for this approach is that the from the perspective of policy makers concerned with inequality it is undesirable to make a distinction between a man and a woman with the same level of expenditure. Moreover, producing inequality measures at the level of the sample facilitates comparisons with the earlier literature.

To understand where the large differences in SEFIC and indifference scales across gender and household type come from we need to turn to the estimation results. Table 4.7 presents the estimates of all parameters related to child utility and the domestic good. We find that equality of the parameters $\alpha_{i,j}^{0,p}$ and $\alpha_{i,j}^{i,p}$ across gender cannot be rejected ($\chi_2^2 = 2.44$). For a man and a woman with the same wage, equation (4.7) then implies that the marginal utility from the domestic good of the man is proportional to that of the woman by a factor $b_2(w_2, p_a; \mathbf{d_2})/b_1(w_1, p_a; \mathbf{d_1})$. This factor tends to be close to 1, so that men and women value the domestic good about equally. The productivity parameter for women's domestic work hours $\gamma_{2,j}^p$ is about the 1.30 times the size of the corresponding parameter $\gamma_{1,j}^p$ for men. This difference is significant ($\chi_1^2 = 36.13$) at the 1% level. Within the context of the model this implies that women's domestic work hours are more "productive" than those of men. However, this ultimately reflects that at equal potential labor income women do more household work than men. An alternative explanation for the domestic work pattern in our data is that it reflects slowly changing traditional role patterns. The model cannot distinguish between these explanations. Whatever the explanation, it is clear that due to these work patterns men in couples benefit considerably by sharing household work relative to men without a partner. Women in couples also benefit from sharing work with their partner, but to a lesser extent. The results for the child good are qualitatively the same as those for the domestic good. We find that equality of the parameters $\alpha_{i,j}^{0,k}$ and $\alpha_{i,j}^{i,k}$ cannot be rejected ($\chi_2^2 = 2.69$). The productivity parameter of women $\gamma_{2,j}^{k}$ is about the 1.36 times the size of the corresponding parameter $\gamma_{1,j}^{k}$ for men. This difference is significant ($\chi_1^2 = 10.27$) at the 1% level.

4.5.2 SEFIC inequality

Table 4.8 reports the variance of log SEFIC for the years 2009-2017. The variance is calculated using the population weights for the corresponding year. The confidence intervals for levels of the variance of log SEFIC are quite wide.[16] We can nonetheless determine year-to-year changes quite precisely. Within a bootstrap replication the levels of SEFIC inequality are determined using the same set of parameter estimates for all years. This induces a strong positive covariance between e.g. the 2009 and 2010 level of SEFIC inequality across bootstrap replications. The (Pearson) correlation between the bootstrapped SEFIC inequality series for different years ranges between 0.986 and 0.999. Consequently, the difference in SEFIC inequality between years has a substantially smaller variance than the levels of SEFIC inequality in those years.

We find that the variance of log SEFIC rises from 2009 to 2010, the change is significant at the 10% level but not the 5% level. The timing of this increase coincides with a severe recession in the Netherlands following the financial crisis in the United States. Figure 4.1(b) shows that, at least for men in our sample, the year 2009-2010 was a period of negative real wage growth. SEFIC inequality falls significantly between 2010 and 2012 a period of weak economic growth. Between and 2012-2013 the Netherlands enters a mild recession, followed by a period of positive economic growth.

[16]The large confidence intervals are primarily the result of variation in two types of parameters. First, across bootstrap replications productivity parameters differ. This changes the economies of scale in domestic good and child welfare production, leading to large differences in SEFIC between singles and couple members across replications. As a result the bootstrapped confidence interval is quite wide. Second, across bootstrap replications the parameters $\alpha_{i,j}^{0,p}$, $\alpha_{i,j}^{i,p}$, $\alpha_{i,j}^{0,k}$ and $\alpha_{i,j}^{i,k}$ differ substantially. This changes, separately for men and women, how much individuals value the domestic good and child welfare.

Table 4.7: Parameter estimates for all household types

Household type	Living alone	Childless couple	Single mother	Two parent
$\alpha_{1,j}^{0,p}$ $\ln(u^p)^a$	-0.540 **	-0.540 **	-	-0.540 **
	(0.038)	(0.038)	(-)	(0.038)
$\alpha_{1,j}^{0,k}$ $\ln(u^k)^a$	-	-	-	-0.166 **
	(-)	(-)	(-)	(0.028)
$\alpha_{1,j}^{1,p}$ $\ln(u^p)^a$	0.116 **	0.116 **	-	0.116 **
	(0.017)	(0.017)	(-)	(0.017)
$\alpha_{1,j}^{1,k}$ $\ln(u^k)^a$	-	-	-	0.035 **
	(-)	(-)	(-)	(0.007)
$\alpha_{2,j}^{0,p}$ $\ln(u^p)^a$	-0.528 **	-0.528 **	-0.528 **	-0.528 **
	(0.030)	(0.038)	(0.030)	(0.030)
$\alpha_{2,j}^{0,k}$ $\ln(u^k)^a$	-	-	-0.232 **	-0.232 **
	(-)	(-)	(0.024)	(0.024)
$\alpha_{2,j}^{2,p}$ $\ln(u^p)^a$	0.115 **	0.115 **	0.115 **	0.115 **
	(0.014)	(0.014)	(0.014)	(0.014)
$\alpha_{2,j}^{2,k}$ $\ln(u^k)^a$	-	-	0.048 **	0.048 **
	(-)	(-)	(0.006)	(0.006)
$\gamma_{1,j}^{k,0\,a}$	-	-	-	0.305 **
	(-)	(-)	(-)	(0.079)
$\gamma_{2,j}^{k,0\,a}$	-	-	0.414 **	0.414 **
	(-)	(-)	(0.105)	(0.105)
$\gamma_{3,j}^{k,1\,a}$	-	-	0.193 **	0.193 **
	(-)	(-)	(0.047)	(0.047)
$\gamma_{1,j}^{p,0\,a}$	0.300 **	0.300 **	-	0.300 **
	(0.028)	(0.028)	(-)	(0.028)
$\gamma_{2,j}^{p,0\,a}$	0.388 **	0.388 **	0.388 **	0.388 **
	(0.033)	(0.033)	(0.033)	(0.033)
$\gamma_{3,j}^{p,0\,a}$	0.669 **	0.669 **	0.669 **	0.669 **
	(0.020)	(0.020)	(0.020)	(0.020)

Clustered standard errors in parentheses, $^{**}p < 0.05$ $^{*}p < 0.10$, - indicates a parameter does not appear in the model. The parameters reported in this table appear in equations (4.3)-(4.8).

The point estimates suggest that SEFIC inequality rises between 2012 and 2015 and falls between 2015 and 2017. We find that the decrease in SEFIC inequality from 2009 to 2017 is significant at the 5% level. Section 4.5.4 discusses similar series for individual (full) consumption, leisure hours, public good expenditure and domestic work hours. Appendix 4.C presents SEFIC inequality series for a sample without single-earner couples and a sample that includes the partners of single earners.

Table 4.8 compares SEFIC inequality to inequality in equivalent household expenditure and inequality in after-tax income. Equivalent household full expenditure equals household full expenditure, $w_1 + w_2 + y$ in equation (4.2) and after tax income equals $w_1 m_1 + w_2 m_2 + y$. Both are divided by the appropriate OECD modified equivalence scale.[17] Household full expenditure is constructed using predicted reservation wages for single-earner couples. After-tax income is constructed using only observable data. The comparison of SEFIC inequality with these household full expenditure essentially tells us what we learn by structurally modeling the allocation decision and analyzing outcomes at the individual level, as opposed to analyzing total household resources and using equivalence scales to make the analysis individual level. We compare SEFIC inequality with after-tax income primarily to see whether the two series show the same pattern over time.

Inequality in SEFIC is higher than inequality in equivalent household expenditure. The difference is significant at the 5% level in all years. Note that the variance of the log SEFIC series is calculated for a sample of individuals while the variance of log full household expenditure is calculated for a sample of households. Consequently within-household inequality is not captured by the latter, but is captured in the SEFIC series. Furthermore, economies of scale in household production increase differences in SEFIC between and within household types thus increasing SEFIC inequality relative to the comparison series. While the SEFIC approach generates a large level difference with respect to the equivalence scaling approach, the two approaches generate qualitatively the same pattern of inequality over time. This results follows from the fact that we found that bargaining weights of men and women were relatively close to being equal. The next subsection elaborates on this point. SEFIC inequality is lower than inequality in after-tax income, though the difference is not significant at the 5% level in all years. The two inequality

[17] The OECD modified scale equals 1 for a single persons, 1.5 for a couple and adds 0.3 for each child, see de Vos and Zaidi (1997).

Table 4.8: Variance of log SEFIC, log equivalized household full expenditure and equivalized after-tax household income

(a) Level

	SEFIC			HH full exp.			After-tax HH income		
Year	Var	95% CI		Var	95% CI		Var	95% CI	
2009	0.164	0.126	0.252	0.107	0.103	0.116	0.234	0.199	0.274
2010	0.169	0.133	0.253	0.111	0.110	0.117	0.212	0.187	0.239
2012	0.147	0.116	0.217	0.106	0.101	0.112	0.221	0.195	0.253
2015	0.157	0.129	0.210	0.119	0.116	0.128	0.240	0.213	0.266
2017	0.148	0.118	0.218	0.104	0.101	0.117	0.239	0.209	0.272

(b) Year-to-year difference

	SEFIC			HH full exp.			After-tax HH income		
Year	Var	95% CI		Var	95% CI		Var	95% CI	
2010-2009	0.005	-0.000	0.008	0.004	-0.002	0.009	-0.022	-0.068	0.023
2012-2010	-0.021	-0.035	-0.016	-0.006	-0.011	-0.004	0.010	-0.030	0.050
2015-2012	0.010	-0.008	0.015	0.014	0.010	0.020	0.018	-0.023	0.056
2017-2015	-0.010	-0.015	0.006	-0.015	-0.019	-0.006	-0.000	-0.042	0.042
2017-2009	-0.016	-0.038	-0.006	-0.003	-0.006	0.006	0.006	-0.043	0.052

Source: Own calculations based on the LISS panel series appear to move in opposite directions between 2009 and 2012.

Table 4.9 focuses on the Gini coefficient and 80/20 ratio of the SEFIC distribution. The 80/20 ratio is defined as total SEFIC of individuals in the upper quintile of the SEFIC distribution divided by total SEFIC of individuals in the lower quintile. We have added comparable series for equivalent disposable income of individuals with wages as their primary income source as published by Statistic Netherlands. In Table 4.9 and all tables that follow we present only the levels of inequality and not year-to-year changes in inequality. We denote year-to-year changes that are significant at the 5% level with an asterisk.[18] SEFIC inequality as measured by the variance of log, Gini coefficient and 80/20 change in qualitatively the same way. For all measures the decrease in inequality from 2010 to 2012 is significant at the 5% level. Each of the other year-to-year changes is significant for at least one measure. During the recession years (2009-2012) SEFIC inequality and income inequality move in opposite directions, as measured by either the Gini coefficient or 80/20 ratio.

Table 4.9: Gini coefficients and 80/20 ratio of the SEFIC distribution

	SEFIC				Disposable income	
	Gini		80/20		Gini	80/20
Year	Pred.	95% CI	Pred.	95% CI	Val.	Val.
2009	0.223	0.193 - 0.270	3.088	2.711 - 3.958	0.229	3.175
2010	0.227	0.200 - 0.268	3.116	2.759 - 3.909	0.228	3.150
2012	0.210*	0.183 - 0.250	2.969*	2.627 - 3.678	0.232	3.246
2015	0.223*	0.200 - 0.253	3.031	2.723 - 3.588	-	-
2017	0.215	0.188 - 0.254	2.872*	2.573 - 3.488	-	-

$*$ indicates that the change with respect to the row above is significant at the 5% level. The 80/20 ratio is defined as total income/expenditure in the upper quintile over total income/expenditure in the lower SEFIC quintile. Source: SEFIC inequality, own calculations based on the LISS panel. Disposable income inequality, individuals with wages as their primary income, Statistics Netherlands.

In Table 4.10 we present SEFIC inequality series constructed by gender: We calculate the variance for a year based on the weighed values of log

[18] As was the case for the variance of log SEFIC, in all inequality series that follow the levels of inequality for different years are strongly positively correlated across bootstrap replications. Looking for overlap in the confidence intervals for different years is thus extremely misleading.

SEFIC for the subsamples of men and women in all household types. We find that SEFIC inequality is somewhat higher for men than for women, but the difference is not significant in any year. SEFIC is distributed more unequally than household full expenditure for both men and women. The difference is significant at the 5% level in all years. For women the difference is significant at the 10% in all years except 2009. The year-to-year changes in SEFIC inequality amongst men and amongst women are qualitatively the same as changes in overall SEFIC inequality. However, the 2009 to 2017 change is significant for men and not significant for women,

Table 4.10: Variance of log SEFIC and log equivalized household full expenditure by gender

	SEFIC		HH full expenditure	
Year	Var	95% CI	Var	95% CI
Men				
2009	0.168	0.132 - 0.225	0.105	0.101 - 0.109
2010	0.170	0.138 - 0.222	0.113*	0.111 - 0.116
2012	0.149*	0.120 - 0.194	0.106*	0.104 - 0.117
2015	0.154	0.127 - 0.187	0.124*	0.120 - 0.129
2017	0.137	0.112 - 0.185	0.110*	0.106 - 0.116
Women				
2009	0.146	0.112 - 0.277	0.109	0.102 - 0.129
2010	0.156*	0.120 - 0.284	0.108	0.107 - 0.119
2012	0.135*	0.105 - 0.243	0.104*	0.095 - 0.113
2015	0.143	0.121 - 0.227	0.111*	0.108 - 0.128
2017	0.144	0.115 - 0.240	0.096	0.091 - 0.123

$*$ indicates that the change with respect to the row above is significant at the 5% level.

At this point you may wonder why we emphasize that (SEFIC) inequality amongst men differs from inequality amongst women. After all we are interested in inequality overall. There are two reasons for our emphasis on gender differences. First, inequality between men and women contributes substantially to overall inequality. Second, our estimation results suggest that looking at SEFIC inequality overall is slightly misleading. We allow that men and women have different preferences towards consumption of leisure, private goods and public goods. Therefore it is entirely possible that a single man and a single woman who have the same level of full consumption expenditure are not equally well off. Our estimation results presented in Appendix 4.A.2 suggest that the assumption of equal preferences should be rejected ($\chi^2_{22} = 46.67$). Moreover, we find that women are more productive in household work, suggesting that they have a larger choice set. If we interpret the SEFIC inequality as a measure of inequality in welfare then we are implicitly treating SEFIC as if it is comparable for men and women. Note that the same can be said about the overall household income or expenditure inequality measures calculated in the literature. Our estimation results reject that preference and productivity parameters of men and women are equal. An important implication of this result is that looking at overall inequality in income/expenditure/SEFIC as a form of welfare inequality can be misleading. Overall inequality does not account for preference and (domestic) productivity differences between men and women which have an impact on welfare. A good example is the 2009 to 2017 difference in SEFIC inequality. We find a significant decrease in inequality for the sample as a whole, the subsample of men, but not the subsample of women. For women SEFIC inequality is at roughly the same level in 2009 and 2017.

Given that we predict strong economies of scale (and high indifference scales) for couple members it will come as no surprise that the inequality in SEFIC arises in large part due to differences between rather than within household types. Table 4.11 splits the sample further and looks at SEFIC inequality by gender and household type. We see that the variance of log SEFIC taken by household types is considerably lower than those taken over all household types. In the next subsection we discuss to what extent variation in SEFIC between household types contributes to the overall variance.

The variance of log SEFIC differs substantially by household type. Inequality between single persons is significantly higher (at the 5% level) than inequality between members of couples households with or without children. Furthermore, the confidence intervals of the variance of log SEFIC for single persons are quite wide. Keep in mind that for singles SEFIC simply equals full expenditure, which is observed in the LISS data. Presumably, full expenditure is relatively unequally distributed amongst singles because this group consists of subgroups such as the never married, divorcées and widow(er)s who differ considerably in terms of age, education and income. The time pattern of SEFIC inequality for some gender and household type subgroups differs from the overall pattern. For women in couples without children, inequality increases monotonically for the entire period. For men in couples

Table 4.11: Variance of log SEFIC by type and gender

	Men		Women	
Year	Var	95% CI	Var	95% CI
Singles[a]				
2009	0.103	0.079 - 0.132	0.145	0.109 - 0.178
2010	0.127	0.091 - 0.164	0.144	0.104 - 0.187
2012	0.106	0.081 - 0.134	0.105	0.078 - 0.136
2015	0.126	0.085 - 0.176	0.145	0.084 - 0.232
2017	0.135	0.086 - 0.193	0.087	0.064 - 0.112
Couples without children				
2009	0.092	0.078 - 0.104	0.064	0.059 - 0.071
2010	0.086*	0.073 - 0.099	0.068*	0.063 - 0.072
2012	0.078*	0.070 - 0.085	0.070*	0.067 - 0.074
2015	0.082	0.071 - 0.100	0.086*	0.074 - 0.101
2017	0.076*	0.061 - 0.088	0.089	0.079 - 0.104
Couples with children				
2009	0.090	0.075 - 0.130	0.096	0.085 - 0.148
2010	0.111*	0.093 - 0.149	0.116*	0.100 - 0.183
2012	0.098*	0.084 - 0.132	0.100*	0.086 - 0.157
2015	0.092*	0.075 - 0.121	0.106	0.088 - 0.151
2017	0.056*	0.050 - 0.101	0.092	0.084 - 0.126

$*$ indicates that the change with respect to the row above is significant at the 5% level.[a] For singles SEFIC equals full expenditure, which is observed in the Arbeidsaanbodpanel data. Confidence intervals for singles are bootstrapped by re-sampling observations.

with children inequality decreases monotonically from 2010 onwards. For all group except women in couples without children and single men SEFIC inequality declines significantly between 2009 and 2017.

4.5.3 Inequality decomposition

As in Lise and Seitz (2011) we split our consumption inequality measure into a part that is due to variance in consumption within households and a part that is due to variance in consumption between households. In section 4.2.2 we denoted by $C_{i,j}$ the level of SEFIC for i being either a man (1) or a woman (2) living in a household of type $j = 1, 2, 3$. Here I add the individual index $s = 1, \ldots, n$, time index $t = 2009, \ldots, 2017$ and household index k. Following Lise and Seitz (2011) we use the following decomposition

$$var(log(C_{i,j}^{s,t})) = var(E(log(C_{i,j}^{s,t})|s \in k)) + E(var(log(C_{i,j}^{s,t})|s \in k)), \tag{4.22}$$

where the first term is the between-household component and the second term is the within-household component of the log SEFIC variance.

Economies of scale differences in consumption between household types were found to have a large effect on differences in SEFIC levels. We therefore further split the between-household component of the variance into a part due to variation between households but within household types and a part due to variation between household types. The between-household component of equation (4.22) can be written as

$$\begin{aligned} var(E(log(C_{i,j}^{s,t})|s \in k)) = {} & var(E(E(log(C_{i,j}^{s,t})|s \in k)|s \in j)) \\ & + E(var(E(log(C_{i,j}^{s,t})|s \in k)|s \in j)), \end{aligned} \tag{4.23}$$

where the first term is the between type component and the second term the between-household within-type component of the variance of log SEFIC.

In Table 4.12 we have split the variance of log SEFIC into the aforementioned three components. The within-household, between-household (but within type) and between-type component account for respectively 15%, 53% and 31% of the overall variance. The within-household component is small relative to the between-household component because we estimated relatively equal bargaining weights. The best available comparison for the size of these components is Lise and Seitz (2011). In their analysis of full consumption, measured as the sum of private consumption, public consumption and the time value of leisure, they find a within-household component of around 0.03-0.05 and a between-household component of around 0.10-0.14. The predictions for between-household component of SEFIC inequality are surprisingly similar. The within-household component is larger in Lise and Seitz (2011) because they estimate relatively unequal bargaining weights. In our case the within-household component arises primarily because men and women benefit from consumption of domestically produced goods to a different extent. In Section 4.5.4 we construct an inequality series for full consumption according to the Lise and Seitz (2011) definition, allowing for a better comparison between the two studies.

The variance components can be compared between household types and gender.[19] The within-household variance is larger for couples with children than for couples without children. The difference is significant at the 5% level in all years except 2015. In other words, SEFIC is distributed more unequally between partners with children than those without. The mean SEFIC values in Table 4.6 already revealed this finding. The between household but within type variance is significantly larger for singles than for couples (with or without children) for all years with the exception of the 2012 difference between singles and couples with children. As mentioned above, the overall variance in log SEFIC does not differ significantly between men and women. The same is true for the variance components. The only exception is the between-household within-type component in 2015 which is significantly higher for women than for men.

The between-household (but within type) component evolves over time in qualitatively the same way as the overall variance. However, it can only account partially for the year-to-year changes in overall SEFIC inequality. For example the large fall in overall inequality from 2010 to 2012 is explained by a simultaneous decrease in all three components. In all other years the components do not move in the same direction.

We now consider how two elements of the model affect the inequality measures we calculate. We check to what extent SEFIC inequality is affected by imposing that each member of a couple controls half the couples' resources. In other words, we set all bargaining weights to 0.5. In the baseline model men on average have lower bargaining weights, but higher levels of SEFIC than women. Reducing inequality in bargaining weights therefore increases SEFIC inequality slightly. SEFIC inequality increases by about 0.03 to 0.05.

[19]These results are not reported in a table but are available upon request.

Table 4.12: Variance of log SEFIC by component

Year	Overall		Within HH	
	Var	95% CI	Var	95% CI
2009	0.164	0.126 - 0.252	0.024	0.018 - 0.046
2010	0.169	0.133 - 0.253	0.026*	0.021 - 0.046
2012	0.147*	0.116 - 0.217	0.023*	0.018 - 0.042
2015	0.157	0.129 - 0.210	0.023	0.017 - 0.038
2017	0.148	0.118 - 0.218	0.024	0.018 - 0.041
Year	Between HH[a]		Between type	
	Var	95% CI	Var	95% CI
2009	0.082	0.078 - 0.099	0.057	0.027 - 0.119
2010	0.090*	0.085 - 0.107	0.052*	0.023 - 0.109
2012	0.078*	0.073 - 0.093	0.047*	0.021 - 0.093
2015	0.093*	0.088 - 0.107	0.041*	0.017 - 0.076
2017	0.073*	0.072 - 0.085	0.051*	0.023 - 0.099

$*$ indicates that the change with respect to the row above is significant at the 5% level.[a] Between household, within type variance

We have also reweighed the 2010-2017 to the 2009 population distribution of household types (defined by the number of adults and children and a marriage dummy), age and education of the household members. We find that the reweighing has negligible effects on the time series of SEFIC inequality. The time pattern we observed for overall SEFIC inequality is not explained by changes in the population's household type distribution over the same period.

4.5.4 Inequality in expenditure and time use

This section discusses inequality in categories of expenditure and time use. The upper half of Table 4.13 reports the variance of log individual full expenditure, and inequality in its components. These are private goods consumption c_i and leisure hours l_i. Inequality in both private consumption and leisure hours increases significantly between 2009 and 2017. Inequality in leisure time is low compared to consumption in private goods. This is unsurprising as leisure consists to a large extent of sleeping and resting. Combining the value of private consumption and leisure ensures that full expenditure is considerably more equally distributed than consumption of private goods. Inequality in individual full expenditure follows qualitatively the same pattern as inequality in SEFIC or household full expenditure.

The lower half of Table (4.13) contains an individual full consumption inequality series that is comparable to the one produced by Lise and Seitz (2011) for the UK. Their measure of full individual consumption includes expenditure on private goods, the time value of non-work time and household expenditure on public goods. We construct this measure as $p_a c_i + w_i(1 - m_i) + p_{na} c^p$. Note that in the TUC dataset all the values of c_i, m_i and c^p are observed. This includes the years 2015 and 2017 were only the values of domestic work hours and leisure hours are missing. Following Lise and Seitz (2011), we calculate the variance of log full individual consumption for a sample of single persons and childless couples. Their estimates of the variance of log full individual consumption lie between 0.13 and 0.19 for the US in the years from 1968 to 2001. In our sample the variance of log starts at a value of 0.10 in 2009 and reaches a high of 0.12 in 2015.

4.6 Conclusion

We studied individual level consumption inequality in the Netherlands between 2009 and 2017. The study is representative of the population of working individuals in households consisting of single persons and couples with and without children. The analysis is based on a measure we call Singles Equivalent Full Individual Consumption (SEFIC), which is derived from indifference scales in the spirit of Browning, Chiappori, and Lewbel (2013). We use a collective model of household production introduced in Cherchye, de Rock, and Vermeulen (2012b) to estimate the utility functions of individuals in the aforementioned household types. Then we determine what level of full expenditure (on all goods, including the time value of leisure and domestic work) they need as a single person to stay on the indifference curve they reach in their true household. SEFIC compensates an individual for the bargaining power they have in the their true household, the higher efficiency of household production when producing with a partner, and the benefit of having a partner that is more productive than themselves.

We find that for the sample as a whole the variance of log individual consumption (measured as SEFIC) declines significantly between 2009 and 2017. The decline is not monotonic however. SEFIC inequality rises significantly from 2009 to 2010, coinciding with a period of negative to weakly

Table 4.13: Variance of log for expenditure and time use categories

	Individual full expenditure $x_i = p_a c_i + w_i l_i$		Private goods[a] c_i		Leisure[a] l_i	
Year	Var	95% CI	Var	95% CI	Var	95% CI
2009	0.143	0.127 - 0.163	0.312	0.274 - 0.352	0.021	0.018 - 0.023
2010	0.160	0.139 - 0.182	0.383*	0.339 - 0.436	0.022	0.020 - 0.025
2012	0.139	0.120 - 0.161	0.415	0.344 - 0.489	0.023	0.020 - 0.025
2015	0.153	0.146 - 0.188	0.600*	0.520 - 0.676	0.023	0.022 - 0.033
2017	0.151	0.145 - 0.164	0.667	0.586 - 0.770	0.027	0.025 - 0.030
	Lise and Seitz (2011) comparison $p_a c_i + w_i(l_i + h_i^p) + p_{na} c^p$		Public goods[a] c^p		Domestic work[a] h_i^p	
Year	Var	95% CI	Var	95% CI	Var	95% CI
2009	0.103	0.092 - 0.116	0.172	0.155 - 0.192	0.584	0.514 - 0.662
2010	0.112	0.099 - 0.126	0.176	0.159 - 0.196	0.538	0.495 - 0.606
2012	0.095	0.085 - 0.106	0.172	0.155 - 0.189	0.541	0.472 - 0.632
2015	0.119*	0.102 - 0.139	0.273	0.227 - 0.338	0.573	0.486 - 0.616
2017	0.099	0.083 - 0.118	0.178	0.152 - 0.208	0.588	0.494 - 0.655

$*$ indicates that the change with respect to the row above is significant at the 5% level. [a] The bottom 5% of these distributions are winsorized as negative predicted values can occasionally occur.

positive real wage growth in the Netherlands. Consumption inequality falls significantly between 2010 and 2012, a period of weakly positive economic growth. Consumption inequality does not track inequality in disposable income as reported by Statistics Netherlands nor after-tax income as reported in our sample, both of which decreased from 2009 to 2010 and increased between 2010 and 2012. When analyzing consumption inequality by gender we found that SEFIC inequality exhibited the same pattern from 2009 to 2015. Thereafter inequality decreases for men but stays roughly constant for women. When splitting the sample by household type we found that two gender-household type subgroups experienced a time pattern that differed qualitatively from the overall pattern. Women in childless couples experienced a monotonic increase in inequality between 2009 and 2017. Men in couples with children experienced a monotonic decline in inequality from 2010 to 2017.

The variance of log consumption is decomposed into parts that are due to variance within households (between household members), variance between households but within household type and variance between household types. Respectively, these components accounts for about 15%, 53% and 31% of the overall variance. The within-household component of the variance of log individual consumption is small and does not vary significantly over time. The time pattern in overall SEFIC inequality is the result of partially offsetting changes in the other two components. The one exception is the large decline in overall inequality from 2010 to 2012, which is the result of a simultaneous decrease in all three components. These results are robust to re-weighting the samples for 2009-2017 to the population distribution over age groups, education groups and household types to an arbitrary base year.

The level of SEFIC varies strongly between household types. Differences between single persons and couples are explained by large difference in estimated productivity parameters for domestic work hours between men and women. The productivity parameter for women is about 1.3 times as high as the corresponding parameter for men. Men in couples receive a large benefit from sharing domestic work with a more productive spouse. Consequently, they tend to be significantly better off than otherwise similar men living alone. Women in couples benefit to a more limited extent from sharing domestic work with their partner. We also find that couple members without children have substantially higher values of SEFIC than comparable members of couples with children. The difference reflects the substantial cost of children that the latter pay.

In future work we hope to apply the analysis in this paper to tax administration data. We would be able to use the structural collective model, estimated on LISS data, to simulate consumption, time use allocations and SEFIC for the administrative dataset akin to what we did for the (incomplete) LISS data for 2015 and 2017. A large administrative dataset would improve the precision with which we can simulate inequality series. The current analysis revealed significant differences in inequality between variables and significant year-to year changes in inequality. However, the estimates for overall SEFIC inequality levels were insufficiently precise to determine much more than that inequality in SEFIC inequality is higher than inequality in household full expenditure. This makes it harder to compare the results with consumption and income inequality studies for other countries or time periods. It is here that the increased precision that comes with using a larger dataset with more precisely measured income data would be especially useful.

Appendix

4.A Estimation

This Appendix contains a detailed discussion of the model used to predict consumption inequality in the main text. Section 4.A.1 discusses the details of estimation. Section 4.A.2 presents the results of estimation. Appendix 4.B derives closed form solutions for singles equivalent consumption and indifference scales. This section ends with a discussion of the predicted levels of singles equivalent consumption and indifference scales within the LISS sample.

4.A.1 Estimation method

We estimate the demand equations discussed above by NLSUR. The system of estimation equations consists of the input demand equations (4.12a)-(4.12f) and the second stage leisure equation (4.16a) and consumption equation (4.16b) of both partners with the first stage equations (4.11a)-(4.11c) substituted in. We then estimate

$$\sum_{h}^{H} \mathbf{u_h'} \boldsymbol{\Omega} \mathbf{u_h}$$

where $\boldsymbol{\Omega}$ is a weighting matrix, $\mathbf{u_h}$ is the (10 by 1) vector of residuals for household h and H is the number of households. Because there are repeated observations in the pooled 2009-2012 waves we cluster at the households level. Residuals for equations that are not applicable for a household type are set to zero. For example, the residual for the woman's consumption is set to zero for single men. In the first stage $\boldsymbol{\Omega}$ is an identity matrix of size 10 and in the second stage

$$\mathbf{\Omega^{-1}} = \frac{1}{H}\sum_{h}^{H} \mathbf{\hat{u}_h \hat{u}_h'},$$

where $\mathbf{\hat{u}_{h,t}}$ are the first stage residuals.

We impose the non-linear constraints in equation (4.5) and (4.10). Furthermore, we equate all child utility and domestic good coefficients ($\alpha_i^{0,p}$, $\alpha_i^{i,p}$, $\alpha_i^{0,k}$ and $\alpha_i^{i,k}$) and all production function parameters (γ and ϵ) across all household types. The former set of restrictions implies that for the same level of the public good an individual in different household types experience the same increase in valuation of private consumption and leisure. The latter set of restrictions implies that in theory all household types produce the same level of child utility/the domestic good for the same levels of inputs if they have the same values of production shifters.[20] These restrictions are needed for identification because we do not have plausible production shifters for childless households. Without such production shifters it is not possible to identify separate household production parameters for childless households types. Preliminary analysis revealed that variables such as the age or education of household members were not significant production shifters.

The equation system is estimated based on pooled 2009, 2010 and 2012 waves of the LISS Time Use and Consumption module. We adjust standard errors for clustering at the household level.

4.A.2 Estimation results

The full set of second stage parameter estimates is presented in Table 4.14. Based on the sharing rule parameters in Table 4.14 we have predicted the bargaining weight for men in couples with and without children. Table 4.15 presents the mean of the predicted bargaining weights of men as well as the mean over total income quartiles. In both couples both with and without children men control on average 47% of resources, while women control 53% of resources.

In either household type the effect of the relative potential labor income ratio has the expected positive sign. The effect is significant for both couples

[20] In practice, it is not possible for single persons to use the same levels of inputs as a couple. Furthermore, it is impossible for childless households to have the same production shifters as households with children since the number of children is a production shifter.

with and without children. However, the effects is weaker for non-parents than for parents. A standard deviation increase in the relative potential labor income ratio has an average marginal effect of increasing a father's share of resources by 4.1 percentage point and a childless man's resource share by 1.8 percentage point. For two-parent households the average marginal effect of the father completing a degree in the higher education is a 1.1 percentage point increase in his share of expenditure. The corresponding effect for mother's education is a 1.1 percentage point decrease in the father's share of expenditure. For couples without children both effects are negative. However, none of these effect are significant. It is primarily differences in relative potential labor income ratio's that explain the difference in mean bargaining weights in Table 4.15.

4.B Derivation of SEFIC

In section 4.2.2 we discussed that the key to finding an expression for Singles Equivalent Full Individual Consumption (SEFIC) is solving the single person's optimization problem

$$\mathcal{L}_{i,s} = v_{i,s} + \mu(C_{i,j} - w_i - \rho_i - G_s^p u_s^p).$$

We find the following first order necessary conditions

$$\begin{aligned}
\frac{\partial \mathcal{L}_{i,s}}{\partial \rho_i} &= \frac{1}{(w_i/p_a)^{\beta_i}} \frac{1}{w_i + \rho_i} - \mu = 0 \quad \rightarrow \qquad \rho_i = \frac{1}{\mu} \frac{1}{(w_i/p_a)^{\beta_i}} - w_i \\
\frac{\partial \mathcal{L}_{i,s}}{\partial u_s^p} &= \frac{1}{(w_i/p_a)^{\beta_{i,s}}} \frac{-\alpha_{i,s}^{p*}}{u_s^p} - \mu G_s^p = 0 \rightarrow G_s^p u_s^p = \frac{1}{\mu} \frac{-\alpha_{i,s}^{p*}}{(w_i/p_a)^{\beta_{i,s}}} \\
\frac{\partial \mathcal{L}_{i,s}}{\partial \mu} &= y - \rho_i - G_s^p u_s^p \qquad\qquad\qquad \rightarrow \qquad \frac{1}{\mu} = \frac{C_{i,j}}{X_{i,s}},
\end{aligned}$$

where

$$X_{i,s} = \frac{1 - \alpha_{i,s}^{p*}}{(w_i/p_a)^{\beta_{i,s}}}$$

and

$$\alpha_{i,s}^{p*}(w_i, p_a) = (\alpha_{i,s}^{0,p} + \alpha_{i,s}^{i,p} \ln(w_i/p_a))$$

Therefore demand for the domestic goods is given by

$$u_s^p(w_i, p_a, C_{i,j}) = \frac{1}{G_s^p} \frac{-\alpha_{i,s}^{p*}}{1-\alpha_{i,s}^{p*}} C_{i,j}$$

From here, we suppress dependence of functions on wages, prices, taste shifters, production shifters and distribution factors to improve readability.

The indifference condition in equation (4.19) of section 4.2.2 implies

$$\frac{\ln(C_{i,j} - G_s^p u_s^p(C_{i,j})) - \ln a_{i,s}(w_i, p_a; u_s^p(C_{i,j}))}{(w_i/p_a)^{\beta_{i,s}}} = \frac{\ln(x_{i,j}) - \ln a_{i,j}(w_i, p_a; u_j^p, u_j^k)}{(w_i/p_a)^{\beta_{i,j}}}$$
$$\ln(C_{i,j} - G_s^p u_s^p(C_{i,j})) - \ln a_{i,s}(w_i, p_a; u_s^p(C_{i,j})) = \frac{\ln(x_{i,j}) - \ln a_{i,j}(w_i, p_a; u_j^p, u_j^k)}{(w_i/p_a)^{\beta_{i,j}-\beta_{i,s}}},$$

where we have substituted in the single person's budget constraint. Taking the exponential function on both sides

$$(C_{i,j} - G_s^p u_s^p(w_i, C_{i,j}))e^{-\ln a_{i,s}(w_i,p_a;u_s^p(w_i,C_{i,j}))} = x_{i,j}{}^{(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}}} \cdot e^{-(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}} \ln a_{i,j}(w_i,p_a;u_j^p,u_j^k)}.$$

Substituting in $\ln a_{i,s}(w_i, p_a; u_s^p(w_i, C_{i,j}))$ gives

$$(C_{i,j} - G_s^p u_s^p(w_i, C_{i,j}))e^{-\alpha_{i,s}^{0,0}} w_i^{-\alpha_{i,s}^{i,0}} p_a^{-(1-\alpha_{i,s}^{i,0})} (u_s^p(w_i, C_{i,j}))^{-\alpha_{i,s}^{p*}} = x_{i,j}{}^{(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}}} \cdot e^{-(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}} \ln a_{i,j}(w_i,p_a;u_j^p,u_j^k)}.$$

which can be rewritten as

$$(C_{i,j} - G_s^p u_s^p(w_i, C_{i,j}))(u_s^p(w_i, C_{i,j}))^{-\alpha_{i,s}^{p*}} = x_{i,j}{}^{(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}}} \cdot e^{\alpha_{i,s}^{0,0}} w_i^{\alpha_{i,s}^{i,0}} p_a^{1-\alpha_{i,s}^{i,0}} e^{-(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}} \ln a_{i,j}(w_i,p_a;u_j^p,u_j^k)}.$$

Substituting $u_s^p(w_i, C_{i,j})$ into the left hand side gives

$$\left(C_{i,j} - \frac{-\alpha_{i,s}^{p*}}{1-\alpha_{i,s}^{p*}} C_{i,j}\right) \left(\frac{1}{G_s^p} \frac{-\alpha_{i,s}^{p*}}{1-\alpha_{i,s}^{p*}} C_{i,j}\right)^{-\alpha_{i,s}^{p*}} =$$
$$\frac{1}{1-\alpha_{i,s}^{p*}} C_{i,j} \left(\frac{1}{G_s^p} \frac{-\alpha_{i,s}^{p*}}{1-\alpha_{i,s}^{p*}} C_{i,j}\right)^{-\alpha_{i,s}^{p*}} =$$
$$\frac{1}{1-\alpha_{i,s}^{p*}} \left(\frac{1}{G_s^p} \frac{-\alpha_{i,s}^{p*}}{1-\alpha_{i,s}^{p*}}\right)^{-\alpha_{i,s}^{p*}} (C_{i,j})^{1-\alpha_{i,s}^{p*}}.$$

Finally we get

$$C_{i,j} = x_{i,j}^{\frac{(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}}}{1-\alpha^{p*}_{i,s}}} e^{\frac{\alpha^{0,0}_{i,s}}{1-\alpha^{p*}_{i,s}}} w_i^{\frac{\alpha^{i,0}_{i,s}}{1-\alpha^{p*}_{i,s}}} p_a^{\frac{1-\alpha^{i,0}_{i,s}}{1-\alpha^{p*}_{i,s}}}$$
$$\cdot\, e^{\frac{-(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}} \ln a_{i,j}(w_i,p_a;u^p_j,u^k_j)}{1-\alpha^{p*}_{i,s}}} \left(\frac{1}{1-\alpha^{p*}_{i,s}}\right)^{\frac{-1}{1-\alpha^{p*}_{i,s}}} \left(\frac{1}{G^p_s}\frac{-\alpha^{p*}_{i,s}}{1-\alpha^{p*}_{i,s}}\right)^{\frac{\alpha^{p*}_{i,s}}{1-\alpha^{p*}_{i,s}}}.$$

which though complicated looking is simply a power function of individual resources in the couples $x_{i,j}$. It's dependence on wages (and taste shifters if we were to add some) is quite complex though. We can substitute $\ln \alpha_{i,j}$ into the previous expression to show how SEFIC depends on the level of child utility and the domestic good produced in the two-parent household.

$$\begin{aligned} C_{i,j} = {} & x_{i,j}^{\frac{(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}}}{1-\alpha^{p*}_{i,s}}} \\ & \cdot\, e^{\frac{\alpha^{0,0}_{i,s}-\alpha^{0,0}_{i,j}(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}}}{1-\alpha^{p*}_{i,s}}} \\ & \cdot\, w_i^{\frac{\alpha^{i,0}_{i,s}-\alpha^{i,0}_{i,j}(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}}}{1-\alpha^{p*}_{i,s}}} \\ & \cdot\, p_a^{\frac{(1-\alpha^{i,0}_{i,s})-(1-\alpha^{i,0}_{i,j})(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}}}{1-\alpha^{p*}_{i,s}}} \\ & \cdot\, {u^p_j}^{\frac{-\alpha^{p*}_{i,j}(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}}}{1-\alpha^{p*}_{i,s}}} \\ & \cdot\, {u^k_j}^{\frac{-\alpha^{k*}_{i,j}(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}}}{1-\alpha^{p*}_{i,s}}} \\ & \cdot\, \left(1-\alpha^{p*}_{i,s}\right)\left(\frac{-\alpha^{p*}_{i,s}}{G^p_s}\right)^{\frac{\alpha^{p*}_{i,s}}{1-\alpha^{p*}_{i,s}}}. \end{aligned} \tag{4.24}$$

In the equation above the level of SEFIC is a function of the levels of individual consumption $x_{i,j}$, child utility u^k_j and the domestic good u^p_j in household type j. Here we substitute these levels into equation (4.20) to find SEFIC as a function of household full expenditure $x = w_1 + w_2 + y$, the bargaining weights Λ_1, Λ_2, the unit costs of child utility G^k_j and the domestic good G^p_j in household type j, and the unit cost of the domestic good when living alone G_s^p

$$
\begin{aligned}
C_{i,j} = {} & x^{\frac{(1-\alpha_{i,j}^{k*}-\alpha_{i,j}^{p*})(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}}}{1-\alpha_{i,s}^{p*}}} \\
& \cdot\ e^{\frac{\alpha_{i,s}^{0,0}-\alpha_{i,j}^{0,0}(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}}}{1-\alpha_{i,s}^{p*}}} \\
& \cdot\ w_i^{\frac{\alpha_{i,s}^{i,0}-\alpha_{i,j}^{i,0}(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}}}{1-\alpha_{i,s}^{p*}}} \\
& \cdot\ p_a^{\frac{(1-\alpha_{i,s}^{i,0})-(1-\alpha_{i,j}^{i,0})(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}}}{1-\alpha_{i,s}^{p*}}} \\
& \cdot\ \left(1-\alpha_{i,s}^{p*}\right)\left(\frac{-\alpha_{i,s}^{p*}}{G_s^p}\right)^{\frac{\alpha_{i,s}^{p*}}{1-\alpha_{i,s}^{p*}}} \\
& \cdot\ {G_j^p}^{\frac{\alpha_{i,j}^{p*}(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}}}{1-\alpha_{i,s}^{p*}}} \\
& \cdot\ {G_j^k}^{\frac{\alpha_{i,j}^{k*}(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}}}{1-\alpha_{i,s}^{p*}}} \\
& \cdot\ \left(\frac{\Lambda_i}{(w_i/p_a)^{\beta_{i,j}}}\right)^{\frac{(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}}}{1-\alpha_{i,s}^{p*}}} \\
& \cdot\ \left[-\frac{\Lambda_1}{(w_1/p_a)^{\beta_{1,j}}}\alpha_{1,j}^{p*}-\frac{\Lambda_2}{(w_2/p_a)^{\beta_{2,j}}}\alpha_{2,j}^{p*}\right]^{\frac{-\alpha_{i,j}^{p*}(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}}}{1-\alpha_{i,s}^{p*}}} \\
& \cdot\ \left[-\frac{\Lambda_1}{(w_1/p_a)^{\beta_{1,j}}}\alpha_{1,j}^{k*}-\frac{\Lambda_2}{(w_2/p_a)^{\beta_{2,j}}}\alpha_{2,j}^{k*}\right]^{\frac{-\alpha_{i,j}^{k*}(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}}}{1-\alpha_{i,s}^{p*}}} \\
& \cdot\ \Bigg[\frac{\Lambda_1}{(w_1/p_a)^{\beta_{1,j}}}(1-\alpha_{1,j}^{k*}-\alpha_{1,j}^{p*}) \\
& +\ \frac{\Lambda_2}{(w_2/p_a)^{\beta_{2,j}}}(1-\alpha_{2,j}^{k*}-\alpha_{2,j}^{p*})\Bigg]^{\frac{-(1-\alpha_{i,j}^{k*}-\alpha_{i,j}^{p*})(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}}}{1-\alpha_{i,s}^{p*}}}
\end{aligned} \tag{4.25}
$$

Hence the derivatives of SEFIC with respect to G_j^k, G_j^p and G_s^p are

$$
\begin{aligned}
\frac{\partial C_{i,j}}{\partial G_j^k} &= \frac{\alpha_{i,j}^{k*}(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}}}{1-\alpha_{i,s}^{p*}}\frac{C_{i,j}}{G_j^k} \\
\frac{\partial C_{i,j}}{\partial G_j^p} &= \frac{\alpha_{i,j}^{p*}(w_i/p_a)^{\beta_{i,s}-\beta_{i,j}}}{1-\alpha_{i,s}^{p*}}\frac{C_{i,j}}{G_j^p}
\end{aligned}
$$

$$\frac{\partial C_{i,j}}{\partial G_s^p} = -\frac{\alpha_{i,s}^{p*}}{1-\alpha_{i,s}^{p*}}\frac{C_{i,j}}{G_s^p}.$$

where the former two are positive and the latter is negative. The derivatives with respect to the bargaining weights are too complex to present here.

4.C SEFIC inequality for alternative samples

In Table 4.16 we present the variance of log SEFIC for alternative samples. The baseline sample consist of singles, single parents and the working adults in single-earner and dual-earner couples with and without children. The second sample excludes single-earner couples from the baseline sample while the third sample adds the non-working partners from single-earner couples. This concerns 653 observations in either case. SEFIC inequality is higher in the sample without single-earner couples than in the baseline sample. The results now suggest that inequality decreases from 2009 to 2010. However, none of the year-to-year changes are significant at the 5% level. The sample that includes partners of single earners has lower inequality than the baseline sample. The year-to-year changes are qualitatively the same as for the baseline sample, although now the 2012 to 2015 increase in inequality and the 2015 to 2017 decrease in inequality are significant.

Table 4.14: Parameter estimates for all household types

Household type	Living alone	Childless couple	Single mother	Two parent
$\alpha_{1,j}^{0,p}$ $\ln(u^p)^a$	-0.540 **	-0.540 **	-	-0.540 **
	(0.038)	(0.038)	(-)	(0.038)
$\alpha_{1,j}^{0,k}$ $\ln(u^k)^a$	-	-	-	-0.166 **
	(-)	(-)	(-)	(0.028)
$\alpha_{1,j}^{1,0}$	1.072 **	1.176 **	-	1.128 **
	(0.025)	(0.072)	(-)	(0.060)
$\alpha_{1,j}^{1,1}$ Age. father/10	0.004	-0.023 **	-	-0.016
	(0.004)	(0.012)	(-)	(0.012)
$\alpha_{1,j}^{1,1}$ Educ. father	0.007	0.032	-	-0.003
	(0.013)	(0.038)	(-)	(0.031)
$\alpha_{1,j}^{1,p}$ $\ln(u^p)^a$	0.116 **	0.116 **	-	0.116 **
	(0.017)	(0.017)	(-)	(0.017)
$\alpha_{1,j}^{1,k}$ $\ln(u^k)^a$	-	-	-	0.035 **
	(-)	(-)	(-)	(0.007)
$\beta_{1,j}^{0}$	-0.401	-0.555 **	-	-0.491 **
	(0.318)	(0.149)	(-)	(0.147)
$\beta_{1,j}^{1}$ Age father/10	0.002	0.040	-	0.027
	(0.057)	(0.026)	(-)	(0.029)
$\beta_{1,j}^{1}$ Educ. father	-0.020	-0.082	-	0.002
	(0.162)	(0.089)	(-)	(0.076)
$\alpha_{2,j}^{0,p}$ $\ln(u^p)^a$	-0.528 **	-0.528 **	-0.528 **	-0.528 **
	(0.030)	(0.038)	(0.030)	(0.030)
$\alpha_{2,j}^{0,k}$ $\ln(u^k)^a$	-	-	-0.232 **	-0.232 **
	(-)	(-)	(0.024)	(0.024)
$\alpha_{2,j}^{1,0}$	1.069 **	1.137 **	1.097 **	1.105 **
	(0.021)	(0.063)	(0.029)	(0.052)
$\alpha_{2,j}^{1,1}$ Age mother /10	0.004	-0.021	0.000	-0.012
	(0.005)	(0.013)	(0.007)	(0.012)
$\alpha_{2,j}^{1,1}$ Educ. mother	-0.035 *	-0.024	0.012	-0.013
	(0.019)	(0.039)	(0.017)	(0.026)
$\alpha_{2,j}^{2,p}$ $\ln(u^p)^a$	0.115 **	0.115 **	0.115 **	0.115 **
	(0.014)	(0.014)	(0.014)	(0.014)
$\alpha_{2,j}^{2,k}$ $\ln(u^k)^a$	-	-	0.048 **	0.048 **
	(-)	(-)	(0.006)	(0.006)

Clustered standard errors in parentheses, $^{**}p < 0.05$ $^{*}p < 0.10$, - indicates this parameter does not appear in the model, ^{a} this parameter is restricted to be equal across household types. The parameters reported in this table appear in equation (4.8). Education is a dummy equal to 1 if the respondent completed a degree in the Dutch higher education system (HBO/WO).

Table 4.14: continued

Household type	Living alone	Childless couple	Single mother	Two parent
$\beta^0_{2,j}$	-0.286 **	-0.511 **	-0.228	-0.420 **
	(0.079)	(0.105)	(0.234)	(0.115)
$\beta^1_{2,j}$ Age. mother/10	-0.004	0.041 **	-0.011	0.020
	(0.018)	(0.019)	(0.059)	(0.027)
$\beta^1_{2,j}$ Educ. mother	0.092	0.031	0.091	0.018
	(0.075)	(0.060)	(0.081)	(0.057)
$\lambda^0_{1,j}$	-	-0.138	-	-0.611 **
	(-)	(0.148)	(-)	(0.152)
$\lambda^1_{1,j}$ Rel. wage	-	0.408 **	-	1.039 **
	(-)	(0.185)	(-)	(0.202)
$\lambda^2_{1,j}$ Non labor inc.	-	-0.038	-	-0.033
	(-)	(0.045)	(-)	(0.057)
$\lambda^3_{1,j}$ Educ. father	-	-0.199	-	0.044
	(-)	(0.178)	(-)	(0.184)
$\lambda^4_{1,j}$ Educ. mother	-	-0.106	-	-0.044
	(-)	(0.151)	(-)	(0.141)
$\lambda^5_{1,j}$ Married	-	-0.098	-	-0.021
	(-)	(0.075)	(-)	(0.062)
$\lambda^6_{1,j}$ Age	-	-0.063	-	0.048
difference/10	(-)	(0.063)	(-)	(0.086)
$\gamma^{k,0\,a}_{1,j}$	-	-	-	0.305 **
	(-)	(-)	(-)	(0.079)
$\gamma^{k,0\,a}_{2,j}$	-	-	0.414 **	0.414 **
	(-)	(-)	(0.105)	(0.105)
$\gamma^{k,1\,a}_{3,j}$	-	-	0.193 **	0.193 **
	(-)	(-)	(0.047)	(0.047)
$\gamma^{p,0\,a}_{1,j}$	0.300 **	0.300 **	-	0.300 **
	(0.028)	(0.028)	(-)	(0.028)
$\gamma^{p,0\,a}_{2,j}$	0.388 **	0.388 **	0.388 **	0.388 **
	(0.033)	(0.033)	(0.033)	(0.033)
$\gamma^{p,0\,a}_{3,j}$	0.669 **	0.669 **	0.669 **	0.669 **
	(0.020)	(0.020)	(0.020)	(0.020)

Clustered standard errors in parentheses, $^{**}p < 0.05$ $^{*}p < 0.10$, - indicates this parameter does not appear in the model, [a] this parameter is restricted to be equal across household types. Education is a dummy equal to 1 if the respondent completed a degree in the Dutch higher education system (HBO/WO). Married is dummy variable. The number of children and mean age of children refer to children living at home.

Table 4.14: continued

Household type	Living alone	Childless couple	Single mother	Two parent
$\epsilon_j^{k,0a}$	-	-	0.100	0.100
	(-)	(-)	(0.106)	(0.106)
$\epsilon_j^{k,1}$ Nr. children^a	-	-	0.000	0.000
	(-)	(-)	(0.029)	(0.029)
$\epsilon_j^{k,2}$ Mean age	-	-	0.182 **	0.182 **
children/10^a	(-)	(-)	(0.075)	(0.075)
$\epsilon_j^{p,0a}$	0.115 **	0.115 **	0.115 **	0.115 **
	(0.032)	(0.032)	(0.032)	(0.032)
$\epsilon_j^{p,1}$ Nr. children^a	-	-	0.013 **	0.013 **
	(-)	(-)	(0.006)	(0.006)
$\epsilon_j^{p,2}$ Mean age	-	-	-0.003	-0.003
children/10^a	(-)	(-)	(0.012)	(0.012)

Clustered standard errors in parentheses, $^{**}p < 0.05$ $^{*}p < 0.10$, - indicates this parameter does not appear in the model, ^{a} this parameter is restricted to be equal across household types. Education is a dummy equal to 1 if the respondent completed a degree in the Dutch higher education system (HBO/WO). Married is dummy variable. The number of children and mean age of children refer to children living at home.

Table 4.15: Predicted mean bargaining weights

Household type	Childless couple	Couple with children
1st quartile	0.4869	0.4685
2nd quartile	0.4839	0.4728
3rd quartile	0.4695	0.4770
4th quartile	0.4555	0.4735
Overall	0.4740	0.4729

Table 4.16: Variance of log SEFIC for the alternative samples

Sample	Baseline		Excl. SEC		Incl. SEP	
Year	Var	95% CI	Var	95% CI	Var	95% CI
2009	0.164	0.126 - 0.252	0.188	0.151 - 0.290	0.155	0.121 - 0.239
2010	0.169	0.133 - 0.253	0.179	0.145 - 0.275	0.165	0.131 - 0.247
2012	0.147*	0.116 - 0.217	0.166	0.134 - 0.241	0.146*	0.116 - 0.215
2015	0.157	0.129 - 0.210	0.178	0.152 - 0.254	0.157*	0.129 - 0.210
2017	0.148	0.118 - 0.218	0.173	0.142 - 0.263	0.140*	0.111 - 0.209

$*$ indicates that the change with respect to the row above is significant at the 5% level. Baseline: A Sample of singles, single parents and the working adults in single-earner and dual-earner couples with and without children. Excl. SEC: The baseline sample excluding single-earner couples. Incl. SEP: The baseline sample including the non-working partner in a single-earner couple. Source: Own calculations based on the LISS panel.

Chapter 5

Conclusion

In this concluding chapter I return to the common themes discussed in the introductory chapter. Results related to these common themes appeared throughout the dissertation. Section 5.1 puts the pieces together to reveal an overall picture. Section 5.2 discusses a number of implications and recommendations that follow from the research findings in this dissertation.

5.1 Common themes and results

5.1.1 Distribution of decision making power

In all of the chapters I estimated bargaining weights for members of multiple-person households. Chapter 2, which focuses only on consumption of market goods by childless couples, finds that women have greater control over the allocation than do men. Women in childless couples control 58% of resources, where resources are defined as the budget spent on market goods. The remaining 42% is controlled by men. Chapters 3 and 4 focus on the allocation of both time and expenditure. In Chapter 3 fathers control about 56% of resources while in Chapter 4 men control about 48% of resources for both parents and non-parents. Chapters 3 and 4 use a broader measure of welfare than Chapter 2. In Chapter 2 welfare depends only on consumption of market goods. In Chapters 3 and 4 welfare also depends on leisure and two forms of household production. Consequently, in Chapter 2 the household budget consists of expenditure on market goods. In Chapters 3 and 4 it also includes the opportunity cost of leisure, domestic work and child care time.

A comparison of the 42% versus 48% male bargaining weight for non-parents in Chapters 2 and 4 respectively would suggest two things. First, the estimated share of the household budget controlled by men is larger when that budget includes the value of leisure (and other time uses) than when it does not. Second, men allocate more of their private resources to leisure (and less to consumption) than comparable women. Consequently, when viewing the allocation of market goods alone men appear to have less control. The Chapter 4 data reveals that for men in childless couples the share of spending on private consumption in total spending on private consumption and leisure is 0.8 percentage point smaller than for women (7.1% versus 7.8%).

The main difference between Chapters 3 and 4 is that in the latter chapter women can have a partner who does not work. The 56% versus 48% male bargaining weight for parents suggest that women with a partner who does not work have greater control over the resource allocation than women whose partner works. The Chapter 4 estimates confirm that the former group has a 7 percentage point higher bargaining weight than the latter group. For men there is a comparable 4 percentage point difference.

5.1.2 Equivalence versus indifference scales

Table 5.1: Equivalence scales versus indifference scales

Adults	Single[a]				Couple			
Children	0	1	2	3	0	1	2	3
Equivalence scale[b]	1	1.33	1.51	1.76	1.37	1.67	1.88	2.06
Individual-level comparison								
1/Equivalence scale	1	0.75	0.66	0.57	0.73	0.60	0.53	0.49
IS Ch.2: Men	1	-	-	-	0.59	-	-	-
IS Ch.4: Men	1	-	-	-	0.84	0.62	0.58	0.54
IS Ch.2: Women	1	-	-	-	0.81	-	-	-
IS Ch.4: Women	1	0.63	0.62	0.60	0.67	0.45	0.42	0.39
Household-level comparison								
Adults/Equivalence scale	1	0.75	0.66	0.57	1.46	1.20	1.06	0.97
IS Ch.2: Men+Women	-	-	-	-	1.41	-	-	-
IS Ch.4: Men+Women	-	-	-	-	1.51	1.07	1.00	0.93

[a] Chapter 4 does not consider single fathers. [b] Source: Statistics Netherlands.

In Chapter 2 and 4 I checked whether equivalence scales are numerically close to the, theoretically more appropriate, alternative of indifference scales. Dutch government agencies such as Statistics Netherlands (CBS) and The Netherlands Institute for Social Research (SCP) use the equivalence scales presented in the first panel of Table 5.1. As an example of their application, consider an economy that consists of one single person and one childless couple. To compare the income levels at the individual level we would assign to both members of the couple their household income multiplied by $1/1.37 = 0.73$. The second panel of Table 5.1 presents these inverted equivalence scales, which are comparable to the indifference scales for men and women derived in Chapter 2 and 4. The first row of the third panel multiplies the inverted equivalence scale by the number of adult members of a household. The result is comparable to the sum of indifference scales of men and women.

In Chapter 2 I calculate indifference scales for a sample of childless two-earner couples aged 18 to 65. These indifference scales average 0.81 for women and 0.59 for men. The indifference scales found for working age women are in line with those found by Cherchye, de Rock, and Vermeulen (2012a) for elderly Dutch women. The indifference scales for working age men are considerably higher than those of elderly men. When household expenditure is multiplied by 1.41, the sum of aforementioned indifference scales, the resulting expenditure level is enough to make both member of the couples indifferent between living in the couple and living alone. In theory the factor of 1.46, reported in the third panel of Table 5.1, should do the same. These figures are quite close, despite the fact that the latter is based on an equivalence scale. However, the equivalence scale does not account for inequality within the household. For this reason misleading implications may be drawn by using it. For instance, if both members of a couple would live alone with 0.73 times the expenditure level of the couple then, given the woman's larger bargaining weight, she would be worse off while her partner would be better off. By using the CBS equivalence scales we thus assume that both members are equally well off. The indifference scales in Chapter 2 are allowed to vary with household expenditure. For the top household expenditure decile male and female indifference scales averaged 0.67 and 0.73 respectively, thus the use of equivalence scales only overestimates the needs of men in couples slightly. However, for the bottom household expenditure decile average indifference scales equal 0.52 and 0.91 for men and women respectively. This implies that any evaluations of income or expenditure by couples which use equivalence scales will tend to paint a far too optimistic picture for women in couples, especially those in low expenditure couples.

Chapter 4 complements the analysis in Chapter 2 by calculating indifference scales for single mothers as well as members of couples with and without children. Indifference is based on a broader welfare measure which depends on consumption of market goods, leisure and domestically produced goods. Indifference scales for childless couples differ from Chapter 2, with men and women in childless couples now on average needing shares of 0.84 and 0.67 respectively. Their sum of 1.51 is still close to the comparable figure of 1.46 implied by the CBS-SCP equivalence scale for childless couples. For two-parent households the sum of indifference scales averages 1.07 if they have one child, 1.00 if they have two and 0.93 if they have three. The equivalence scales in Table 5.1 imply that parents jointly need shares of household expenditure of 1.20, 1.06 and 0.98 for one, two and three children respectively. The equivalence scales for two and three children are not that different from the sum of indifference scales of the parents. However, the equivalence scale for one child overestimates the needs of parents quite a bit. The same is true for single mothers with one child. I find qualitatively the same results when comparing indifference scales to other popular equivalence scales such as the OECD modified scale or square root scale.

5.2 Implications and recommendations

5.2.1 Accuracy of equivalence scales

Chapter 2 and 4 imply that the use of equivalence scales for expenditure comparisons across household types is misleading due to the existence of inequality within the household. The model of Chapter 4 is based on a broader measure of welfare than Chapter 2. In making recommendations I therefore follow the results of Chapter 4. The results of Chapter 4, presented in Table 5.1, imply that needs of men in couples are underestimated by equivalence scaling relative to the needs of single men. The problem is especially severe for households with more children and households with higher expenditure. For these groups within-household inequality is stronger. The needs of women in couples are overestimated relative to single women. The effect is stronger for households with children and households with higher expenditure. The use of equivalence scales for consumption comparisons across household types can result in misleading conclusions. This can have important consequences if for example the objective is to evaluate policy effects on income or consumption expenditure distributions. I recommend the use of indifference scales instead. The results suggest that such indifference scales should be allowed to vary with household income or expenditure.

5.2.2 Equivalence scales and poverty lines

In SCP and CBS (2014) the poverty lines of couples are produced by multiplying the poverty line of singles by the appropriate equivalence scale. Section 5.1 identified a number of groups whose needs are understated or overstated relative to single person households by equivalence scales. Moreover, the equivalence scaling approach is based on the rejected assumption of income pooling. Chapter 2 proposed a refined poverty rate for couples. This poverty line is defined so that both members of a couple are as well off as a person at the single person poverty line. In their publications CBS and SCP use a single person poverty line of €1010. The corresponding (traditional) couples poverty line is €1390. I estimate that the refined couples poverty line should be €1781. I recommend that the type of couples poverty line proposed in Chapter 2 be used to calculate poverty rates. It offers a clearer definition of what it means for a couple to be in poverty. According to this definition, a couple is in poverty if at least one of its members is less well off than a single person at the poverty line. Traditional poverty lines (miss)classify as out of poverty some households where one person is better off and the other person is worse off than a single person at the poverty line.

I do not necessarily recommend the use of the specific poverty line value calculated in Chapter 2, because the underlying model is based on a narrow measure of welfare. As the comparison of indifference scales from Chapter 2 and Chapter 4 revealed, adopting a broader measure of welfare can lead to significantly different conclusions. I would recommend calculating a refined couple poverty line using a model that adopts a broader concept of welfare. Such a welfare function could depend on leisure in addition to consumption of market goods, but would preferably depend on a broader set of variables (e.g. levels of domestically produced goods).

5.2.3 Equivalence scales and inequality measurement

In general it would seem advisable to use indifference scales in place of equivalence scales to cross-sectionally compare levels of income or expenditure over a population composed of various household types. Studies of income and consumption inequality are amongst the types of analysis that benefit most from this approach. Equivalence scales do not capture within-household inequality. Chapter 4 revealed that the within-household component of inequality in individual full consumption is small in the Netherlands, but certainly not negligible. Moreover, there is no guarantee that the within-household component will stay small forever.

The approach of Chapter 4 is to create a singles equivalent individual consumption series using indifference conditions from a structural collective decision making model. The underlying model would need to be re-estimated regularly because the indifference scales depend on preference, productivity, and bargaining parameters. These parameters are likely subject to change over time. Nonetheless, this approach is preferable to using equivalence scales. Chapter 4 revealed that the latter approach is guaranteed to underestimate inequality. Lise and Seitz (2011) have shown that it may also misrepresent changes in inequality. Finally, Chapter 4 shows that equivalence scales ignore economically significant heterogeneity in economies of scale within and between household types.

5.2.4 Effects of an increase in daycare cost

In Chapter 3 I predict that the 2011-2013 daycare subsidy cuts led to a strong reduction in daycare use and a weak reduction in work hours (conditional on working) by either parent. I found negligible effects on other expenditure and time use categories. From the government's perspective these results may at first appear to be good news. It appears to be possible to reduce the cost of the subsidy program without affecting work hours. One might hope that this meant that high daycare cost are merely a hurdle to start using daycare (and working more hours). Once parents use daycare the high daycare subsidy may no longer be necessary to sustain higher daycare use and work hours. Chapter 3 suggest that this is wishful thinking. A reduction of the subsidy rate does not reduce labor. However, it strongly reduces daycare use. Moreover, we have predicted only the intensive margin effect of the subsidy cut.[1] Parental labor supply may decline due to a reduction in the employment rate as well. Assuming the effect on the employment rate is symmetrical with respect to increases and decreases in the cost of daycare, the results of Bettendorf, Jongen, and Muller (2015) would suggest a decline of the maternal employment rate.

Finding no decline in hours worked may not be a good thing when, as I find in Chapter 3, parents reduce daycare use without increasing their own child care time. It is unlikely that parents would find no alternative for daycare. However, it is possible that the alternative offers lower quality care or imposes hidden costs. Moreover, if child care is shifted to informal providers then it raises new questions. Who is providing this child care and are they are adequately compensated for it? Roeters and Bucx (2018) report that grandparents are the main informal care provider in the Netherlands by a large margin. A concern that has repeatedly surfaced in the Dutch media is whether increased reliance on grandparents for child care negatively affects the welfare of grandparents. This seems like a reasonable concern, and one that deserves to be studied. The results of Chapter 3 strongly suggest that subsidy rate cuts have costs not captured by the model. New data is needed to study the effect of daycare subsidy changes on the welfare of children and informal care providers. I strongly recommend that such data are collected if the generosity of daycare subsidies is changed again in the future.

[1] I do not predict the participation decision for labor supply. In principle this is possible in the model of Chapter 3 by looking at the net number of individuals that switch from negative to positive latent labor supply. The problem is that the subsidy rate depends on the labor supply decision of the parents and vice versa. At the margin the effect of labor supply on the subsidy rate is negligible. However, when an individual stops working the subsidy rate jumps to zero. This endogenous price change is not accounted for in the model. Therefore, I only predict the policy effect for post-reform two-earner households.

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Samenvatting (Summary in Dutch)

In de afgelopen jaren lijkt er een hernieuwde maatschappelijke en wetenschappelijke interesse te zijn gekomen voor economische ongelijkheid. Economische ongelijkheid bestaat wanneer mensen niet in dezelfde mate beschikking hebben over kansen en middelen om hun economisch welzijn te verbeteren. Economisch welzijn is een fundamenteel subjectief begrip. Hoewel het kan worden gemeten (bijvoorbeeld in een enquête), is economisch welzijn moeilijk te vergelijken voor verschillende personen. Economisch welzijn wordt in belangrijke mate ontleend aan de consumptie van goederen en diensten. Studies van inkomens- en vermogensongelijkheid kunnen een beeld geven van economische ongelijkheid. Immers, wordt er gemeten in welke mate er ongelijkheid bestaat in de middelen die men beschikbaar heeft voor consumptie. Dit is een objectieve dimensie van economische ongelijkheid. Recente studies laten zien dat inkomens- en vermogensongelijkheid zijn toegenomen in Europa en de Verenigde Staten. In deze dissertatie volg ik een meer directe aanpak door ongelijkheid in daadwerkelijke consumptie te bestuderen. In vergelijking met inkomen of vermogen is consumptie een betere maatstaf van individueel welzijn gedurende de levensloop. Onderzoek toont aan dat mensen door middel van hun spaargedrag proberen te voorkomen dat tijdelijke lage inkomens leiden tot grote veranderingen in consumptie. Over de levensloop gezien is er dan ook een sterkere correlatie tussen consumptie en welzijn dan tussen inkomen en welzijn. Om deze reden concentreert dit onderzoek zich op consumptie als een maatstaf van ongelijkheid in economisch welzijn.

In deze ongelijkheidsanalyse worden de consumptieniveaus van huishoudens met elkaar vergeleken. Een directe vergelijking is enkel betekenisvol als we zeker kunnen zijn dat ieder lid van een huishouden de volledige consumptiewaarde van gekochte goederen geniet. Dit is in principe alleen het geval voor eenpersoonshuishoudens. Immers kan, bij wijze van voorbeeld, voedsel maar een keer gegeten worden. Om betekenisvolle vergelijkingen te maken tussen andere types huishoudens, gebruiken onderzoekers traditioneel zogenaamde equivalentieschalen. Een equivalentieschaal wordt gedefinieerd als E_h/E, waar E_h de uitgaven zijn die een huishouden van type h nodig heeft om een gelijk welzijnsniveau te behalen als een alleenstaande met uitgaven E. Equivalentieschalen worden gebruikt om de uitgaven van huishoudens van type h te delen. Het idee is dat de geschaalde uitgaven equivalent zijn aan die van een alleenstaande met hetzelfde welzijnsniveau. Een vergelijking van de geschaalde uitgaven is vervolgens mogelijk.

Browning, Chiappori en Lewbel (2013) bespreken twee conceptuele problemen van equivalentieschalen. Het eerste probleem is dat de methode gebaseerd is op het vergelijken van welzijnsniveaus tussen personen. Dit veronderstelt dat welzijnsniveaus hetzelfde betekenen voor verschillende personen. Dit is een zeer sterke aanname, die niet empirisch onderbouwd is. Economen mijden deze aanname over het algemeen. Het tweede probleem is dat de methode gebaseerd is op een unitair model van beslissingen binnen huishoudens. Deze modellen beschouwen het huishouden als een enkele entiteit die beslissingen neemt en welzijn ervaart. Echter wordt over het algemeen aangenomen dat individuen, en niet huishoudens, welzijn ervaren. Bovendien zijn unitaire modellen niet in staat belangrijke aspecten van het gedrag van huishoudens te verklaren. Studies zoals Blumberg (1988), Bourguignon e.a. (1993) en Browning, Bourguignon e.a. (1994) laten zien dat de wijze waarop een huishouden zijn budget over goederen verdeelt afhankelijk is van wie in het huishouden inkomen ontvangt. Het unitaire model impliceert echter dat dit niet het geval kan zijn. Zogenaamde collectieve modellen gaan er vanuit dat beslissingen worden genomen door meerdere leden. Studies die dergelijke modellen gebruiken vinden een positieve relatie tussen de mate waarin een individu invloed heeft op de beslissingen van het huishouden en het persoonlijke inkomen van die persoon (over het algemeen relatief inkomen ten opzichte van de partner). Dergelijke studies kunnen verklaren waarom de verdeling van uitgaven over goederen afhankelijk is van de inkomensverdeling binnen het huishouden.

Als alternatief voor equivalentieschalen introduceren Browning, Chiappori en Lewbel (2013) zogenaamde indifferentieschalen. Een indifferentieschaal wordt gedefinieerd als het percentage van een huishoudens daadwerkelijke uitgaven dat een lid nodig heeft om diens welvaartsniveau te handhaven wanneer hij/zij alleenstaand zou zijn. Indifferentieschalen zijn gebaseerd op collectieve modellen en veronderstellen geen vergelijking van welzijnsniveaus tussen personen. Indifferentieschalen hangen positief af van de individuele consumptie. Wanneer individuele consumptie ongelijk is verdeeld binnen het huishouden, dan pikken indifferentieschalen dit op. Dit is voor equivalentieschalen niet het geval, omdat ze gebaseerd zijn op een unitair model. In deze dissertatie maak ik gebruik van indifferentieschalen om op individueel niveau consumptie te vergelijken voor verschillende types huishoudens. Het algehele doel van de dissertatie is om, door het gebruik van collectieve modellen en gedetailleerde micro-panel data, beleidsrelevante vragen op het gebied van het (micro)economisch gedrag van huishoudens te beantwoorden.

Hoofdstuk 2 behandelt hoe huishoudens beslissen om hun budget te verdelen over consumptiegoederen. Ik concentreer me op de vraag of individuele voorkeuren van alleenstaanden verschillen van voorkeuren van samenwonenden (zonder kinderen). Deze vraag kan wel worden beantwoord in de context van een collectief model, maar niet in de context van een unitair model. In het laatste geval spelen individuele voorkeuren immers geen expliciete rol. In het eerste geval is het een open vraag welke rol voorkeursverschillen spelen in het verklaren van de verschillende uitgavenpatronen van alleenstaanden en samenwonenden. Deze verschillende patronen zijn ook te verklaren vanuit schaalvoordelen die samenwonenden genieten ten opzichte van alleenstaanden.[1] Bovendien worden de uitgaven van samenwonenden bepaald door de mate waarin de man dan wel de vrouw invloed heeft binnen het huishouden. Als men enkel bestedingsgegevens per goed op huishouden-niveau observeert, dan kan men de rol van deze alternatieve verklaringen niet onderscheiden. Met andere woorden; er is sprake van een identificatieprobleem. Zonder betere data of extra identificerende aannames is een pure test van voorkeursverschillen niet mogelijk. Dunbar, Lewbel en Pendakur (2013) bijvoorbeeld vergelijken binnen een collectief model parameters van alleenstaanden en samenwonenden. Echter is deze test niet 'puur', omdat de parameters zowel voorkeursverschillen als schaalvoordelen reflecteren.

Hoofdstuk 2 introduceert een nieuwe identificerende aanname voor collectieve modellen. Deze aanname volstaat om voorkeursverschillen te testen als er minstens twee goederen zijn waarvan bekend is hoeveel elk individu ervan consumeert. In hoofdstuk 2 gebruik ik de Time Use and Consumption (TUC)

[1]Met schaalvoordelen wordt de mate bedoelt waarin samenwonenden voordeel ondervinden, doordat goederen gedeeld kunnen worden, b.v. het huis, de meubels of voertuigen.

module van het Longitudinal Internet Studies for the Social sciences (LISS) panel. Deze dataset bevat uitgavendata voor 20 goederen-categoriën. Voor 10 categorieën is individuele consumptie bekend. De identificerende aanname is dat alleenstaanden en samenwonenden dezelfde voorkeuren hebben wat betreft de verdeling tussen toewijsbare en niet toewijsbare goederen en de verdeling onder niet toewijsbare goederen. In tegenstelling tot de aanname in bijvoorbeeld Browning, Chiappori en Lewbel (2013) kunnen voorkeuren wat betreft de verdeling onder toewijsbare goederen verschillen. Ik test de hypothese dat alleenstaanden en samenwonenden dezelfde voorkeuren hebben wat betreft de verdeling van uitgaven onder toewijsbare goederen. Deze hypothese wordt verworpen. Het collectieve model waarbij voorkeuren afhangen van samenwonen kan verschillen in uitgavenpatronen tussen alleenstaanden en samenwonenden beter verklaren dan een model waarbij dit niet het geval is.

Verder bereken ik in hoofdstuk 2 indifferentieschalen ter waarde van gemiddeld 0.59 en 0.81 van de uitgaven van het huishoudens voor respectievelijk samenwonende mannen en vrouwen. De schalen voor mannen en vrouwen liggen dichter bij elkaar naarmate de totale uitgaven van het huishouden hoger zijn. Gebruikmakend van deze gegevens bereken ik dat een samenwonend stel uitgaven ter waarde van €1781 per maand nodig heeft, willen beiden minstens het welzijnsniveau bereiken van een alleenstaande met uitgaven gelijk aan de armoedegrens (€1100 per maand). Dit bedrag kan geïnterpreteerd worden als een armoedegrens voor samenwonenden zonder kinderen. Deze armoedegrens is aanzienlijk hoger dan het begrip dat gehanteerd wordt in rapporten van onder meer het Sociaal en Cultureel Planbureau (SCP) en het Centraal Planbureau (CPB). Dit impliceert dat armoede onder samenwonenden over het algemeen onderschat wordt.

In hoofdstuk 3 gebruik ik een collectief model om de relatie tussen de kosten van formele kinderopvang en het gebruik daarvan te bestuderen. Deze analyse concentreert zich op de effecten van een serie reducties van de kinderopvangtoeslag in de jaren 2011, 2012 en 2013. Hiervoor gebruik ik de LISS TUC module voor de jaren 2009, 2010, 2012 en 2015. Naast het effect op het gebruik van kinderopvang, bestudeer ik effecten op het aantal uren dat beide ouders werken en het aantal uren dat ze voor de kinderen zorgen.

Recente studies vinden bewijs dat een afname van kinderopvangkosten leidt tot een toename van het aantal door moeders gewerkte uren (zie b.v. Kornstad en Thoresen 2007, Bettendorf, Jongen en Muller (2015), Hardoy en

Schøne (2015) en Apps, Kabátek e.a. 2016). Hoofdstuk 3 onderscheidt zich van deze studies door het effect van een lagere kinderopvangtoeslag te schatten met behulp van een structureel collectief model. Het structurele model biedt de mogelijkheid het gedrag (o.a. arbeidsuren en kinderopvanguren) van ouders te voorspellen in het hypothetische scenario dat in 2012 en 2015 de oude hogere kinderopvangtoeslag beschikbaar was. Een vergelijking met het (voorspelde) gedrag bij de werkelijke toeslag identificeert het effect van de verlaging van de kinderopvangtoeslag. Ik gebruik een aangepaste versie van het collectieve model van Cherchye, de Rock en Vermeulen (2012b). Dit model stelt ons in staat de beleidseffecten te schatten op het aantal uren dat ouders besteden aan kinderopvang, huishoudelijk werk en vrije tijd.

De verlaging van de kinderopvangtoeslag heeft geleid tot een verhoging van de netto kosten van kinderopvang met gemiddeld 53% voor de ouders in de steekproef. Als gevolg hiervan verminderden ouders hun bruto uitgaven aan kinderopvang met gemiddeld 42%. Het aantal uren kinderopvang neemt ruwweg proportioneel hiermee af. Verrassend genoeg heeft de beleidsverandering geen substantieel effect op het aantal uren besteed aan werk of zorg voor eigen kinderen. De resultaten impliceren dat ouders minder uren kinderopvang gebruiken, maar dit niet compenseren door zelf meer voor de kinderen te zorgen. Het lijkt aannemelijk dat ouders informele kinderopvang aanspreken. Het SCP rapporteert dat grootouders de voornaamste bron van informele kinderopvang zijn. Zulke zorg wordt niet altijd vergoed. Het is daarom mogelijk dat het verlagen van de kinderopvangtoeslag onbedoelde negatieve effecten heeft op het welzijn van informele kinderverzorgers zoals grootouders.

Hoofdstuk 4 bestudeert individuele consumptie-ongelijkheid voor de werkzame bevolking van Nederland van 2009 tot 2017. Ook in dit hoofdstuk wordt de LISS TUC module gebruikt. Zoals eerdergenoemd gebruik ik indifferentieschalen om de consumptieniveaus van personen in verschillende types huishoudens te vergelijken. Ik bereken indifferentieschalen op basis van een versie van het collectieve model van hoofdstuk 3. Deze versie is zodanig aangepast dat het model toepasbaar is op alleenstaanden en samenwonenden met of zonder kinderen. Ten opzichte van hoofdstuk 2 wordt hier een bredere definitie van 'consumptie-uitgaven' gebruikt. In hoofdstuk 4 omvat consumptie zowel uitgaven aan goederen, als ook de waarde van vrije tijd en huishoudelijk werk. Door per individu het uitgaveniveau van het huishouden te vermenigvuldigen met de individuele indifferentieschaal creëer ik een consumptie-uitgave serie genaamd SEFIC. SEFIC is vergelijkbaar voor de eerdergenoemde types huishoudens.

De analyse in hoofdstuk 4 toont dat SEFIC-ongelijkheid afnam tussen 2009 en 2010, toenam tussen 2010 en 2012 en niet significant veranderde tussen 2012 en 2017. Over de gehele periode 2009-2017 neemt SEFIC-ongelijkheid significant af. In dezelfde periode is echter geen sprake van een significante verandering in inkomensongelijkheid. Consumptie-ongelijkheid is lager wanneer consumptie-uitgaven geschaald worden met equivalentieschalen (de traditionele methode) dan wanneer er indifferentieschalen gebruikt worden (zoals bij SEFIC).[2] De traditionele methode onderschat consumptie-ongelijkheid dus aanzienlijk. Dit is het gevolg van het negeren van ongelijkheid binnen het huishouden. SEFIC-ongelijkheid is lager dan (netto) inkomensongelijkheid. Zoals in Lise en Seitz (2011) is SEFIC-ongelijkheid uit te splitsen naar ongelijkheid binnen het huishouden en ongelijkheid tussen huishoudens. Deze componenten verklaren respectievelijk 15% en 85% van de totale variantie van SEFIC. Het laatstgenoemde getal is de som van ongelijkheid tussen huishoudens van hetzelfde type (53%) en ongelijkheid tussen types huishoudens (31%).

Hoofdstuk 5 behandelt enkele centrale thema's van de dissertatie. Gerelateerde resultaten uit verschillende hoofdstukken worden vergeleken. Zo wordt er besproken in welke mate de man dan wel de vrouw invloed heeft op de beslissingen van een samenwonend paar. De invloed van vrouwen is gemiddeld groter dan die van mannen in kinderloze paren. Dit is in meerdere mate het geval in hoofdstuk 2, waar een beslissing over uitgaven aan goederen wordt genomen, dan in hoofdstuk 4, waar ook een beslissing over tijdsbesteding wordt genomen. Uit hoofdstuk 3 en 4 blijkt dat voor zowel mannen als vrouwen geldt dat de groep met een werkende partner minder invloed heeft dan de groep met een niet-werkende partner. Verder vergelijkt hoofdstuk 5 de indifferentieschalen uit eerdere hoofdstukken met equivalentieschalen die in de praktijk worden gebruikt. Ten opzichte van indifferentieschalen onderschatten equivalentieschalen de behoeften van samenwonenden ten opzichte van alleenstaanden. Voor vrouwen geldt dat de behoeften van samenwonenden juist overschat worden. De mate van onderschatting (dan wel overschatting) is groter hoe meer kinderen een huishouden heeft en hoe hoger het uitgave-niveau. Door equivalentieschalen te gebruiken kan men tot

[2]Hiervoor worden equivalentieschalen van OESO gebruikt. Deze zijn gelijk is aan 1 voor alleenstaanden en 1.5 voor koppels plus 0.3 voor elk kind.

misleidende conclusies omtrent welzijn komen. Zo laat hoofdstuk 2 zien dat een op equivalentieschalen gebaseerde armoedegrens voor samenwonenden te laag is. Hoofdstuk 4 laat zien dat consumptie-ongelijkheid lager uitvalt wanneer equivalentieschalen gebruikt worden om verschillende types huishoudens te vergelijken.